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This report is a general description of the major industries which are responsible for shipments of major commodities via the Great Lakes. These industry studies define the general framework for projection of bulk cargo forecasts.

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FOR
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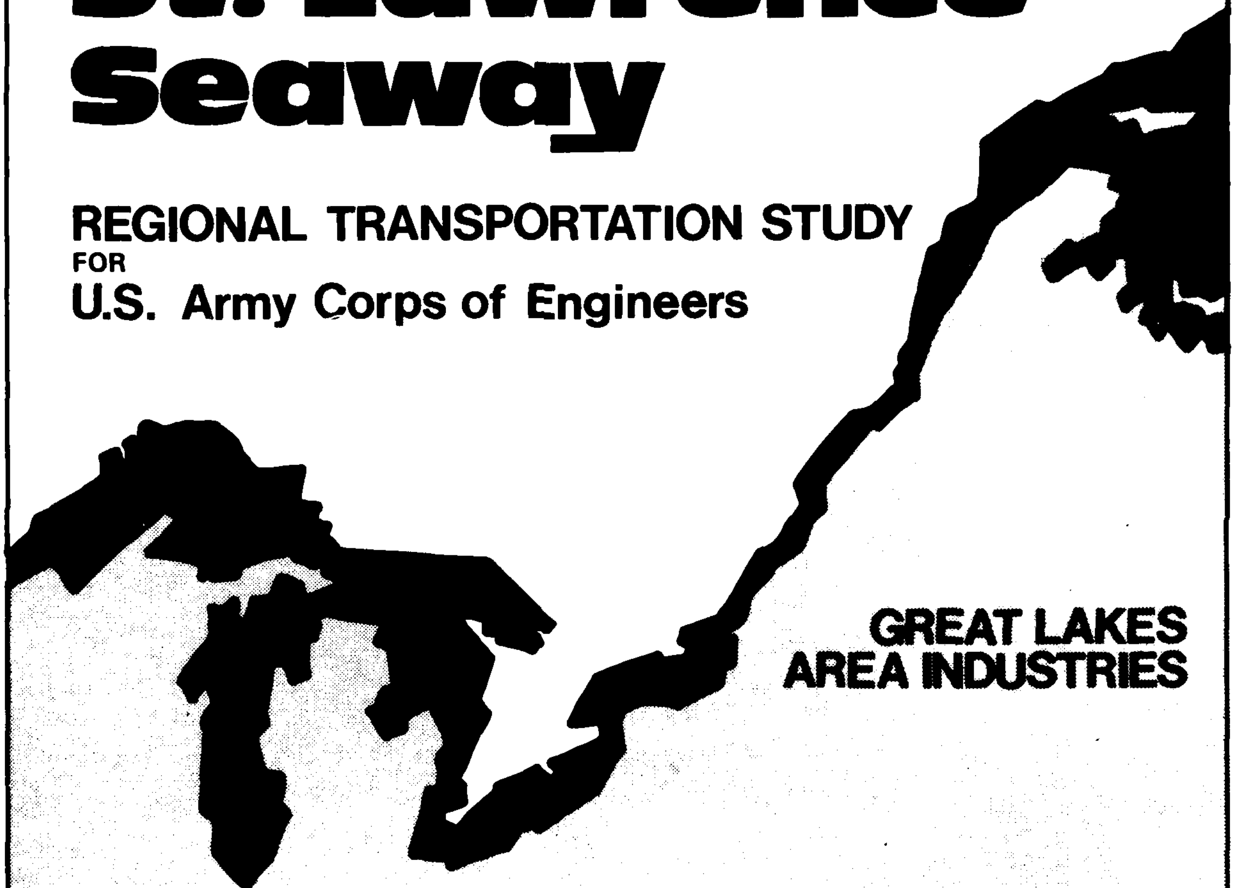

GREAT LAKES AREA INDUSTRIES

BOOZ·ALLEN & HAMILTON INC.

IN ASSOCIATION WITH ARCTEC, Inc.

SEPTEMBER 1981

GREAT LAKES/ST. LAWRENCE SEAWAY
REGIONAL TRANSPORTATION STUDY

GREAT LAKES AREA INDUSTRIES

November 1981

for

U.S. Army Corps of Engineers

by

Booz·Allen & Hamilton Inc.
in association with
ARCTEC, Inc.

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I. INTRODUCTION

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The U.S. Army Corps of Engineers is responsible for maintaining navigability in U.S. rivers, waterways, and harbors. The Corps currently maintains a navigation system of 25,000 miles of improved channels and 219 locks and dams connecting large regions of the country. Feasibility analysis and planning that precede lock and channel construction and maintenance are integral components of navigation system projects. The Great Lakes/St. Lawrence Seaway Regional Transportation Study is an element of this planning process.

The objective of the GL/SLS Regional Transportation Study is to develop an up-to-date, working analytical tool for economic analysis of GL/SLS transportation system improvements. The near-term uses of study information are feasibility studies of three Great Lakes navigation system improvements. These studies are the following:

- The St. Lawrence Additional Locks Study, which will determine the adequacy of the existing locks and channels in the U.S. section of the seaway in light of present and future needs.

- The Great Lakes Connecting Channels and Harbor Study, which will determine the feasibility of providing navigation channel, harbor and lock improvements to permit transit of vessels up to the maximum size permitted by the possible replacement locks at Sault Ste. Marie.

- The Great Lakes/St. Lawrence Seaway Navigation Season Extension Study, which considers the feasibility of means of extending the navigation season on the entire system.

The Regional Transportation Study is organized in two phases. Phase I has the following elements:

- Development of cargo flow forecasts for the Great Lakes system

- Development of data bases required for the evaluation of national economic development (NED) benefits and costs of navigation system improvements

- Evaluation of lock system performance and ability to process future cargo flows

- Evaluation of the performance and economic feasibility of improvements to increase the capacity of the system.

Phase II of the study assesses the regional economic, social, intermodal and energy use impacts of alternative improvements.

This report documents studies of the industries in the Great Lakes area which are responsible for shipments of the major commodities using the Great Lakes system. These industry studies were used to help define the framework for developing cargo flow forecasts.

II. SUMMARY

II. SUMMARY

Studies of the industries which control shipments of the major commodities using the Great Lakes system were developed. Separate reports were prepared for the grain and steel industries and for the industries which are major coal consumers in the Great Lakes area. These reports describe the industries in the following terms:

- Historical trends and outlook for production and consumption of major commodities
- Location of major plants (steel mills and power plants) or production areas (grains)
- Trends and outlook for Great Lakes shipments
- Alternative raw material sources
- Commodity distribution systems.

The remainder of this report is organized in four chapters devoted to the following industries:

- Iron and steel industry
- U.S. grain industry
- Canadian grain industry
- Industries consuming steam coal.

III. IRON AND STEEL INDUSTRY

III. IRON AND STEEL INDUSTRY

1. INDUSTRY OVERVIEW

This section provides an overview of the basic iron and steel industry, with particular reference to the industry within the Great Lakes area. The section is organized as follows:

- Basic steelmaking processes
- Production centers in the U.S. and Canada
- The industry in the Great Lakes area.

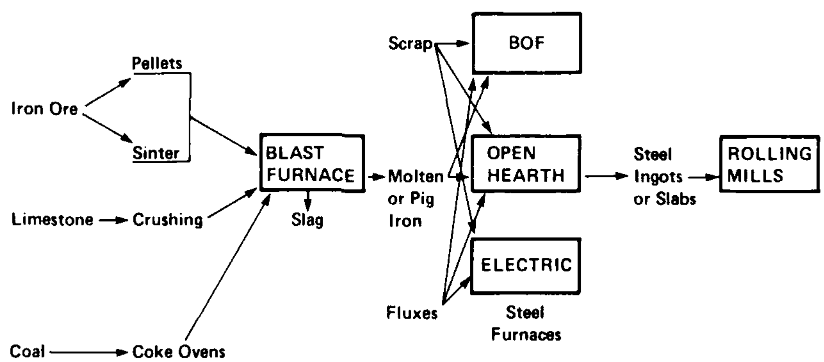
These subjects are discussed below.

(1) Basic Steelmaking Processes

A great variety of products are made from steel. A large quantity of different types of raw materials are required to produce this output, and a number of different technologies are utilized. This is illustrated in Figure III-1. There are three basic aspects of the steelmaking process:

- Raw materials
- Furnace types
- Iron and steel products.

Each of these is discussed below.



Source: American Iron and Steel Institute.

FIGURE III-1
Essential Flowchart for Steelmaking

1. Raw Materials

The basic raw materials consumed in the production of steel are iron ore, coke, limestone and scrap steel. Table III-1 shows the amounts of each material consumed in 1979 in the United States. The use of each of these materials is described below.

TABLE III-1
Materials Used in U.S. Steelmaking
(1979)

Material	Thousands of Net Tons	Net Tons per Ton of Steel Produced
Iron ore pellets and other agglomerates	137,386	1.01
Steel scrap	81,705	0.60
Coke	51,891	0.38
Limestone and other fluxes	27,273	0.20
Raw steel produced	136,361	--

Source: American Iron and Steel Institute.

Iron Ore--In 1979, 137 million tons of iron ore was consumed in U.S. steel mills. The major portion of the iron ore consumed in Great Lakes mills comes from the Lake Superior area. Smaller amounts are obtained from the Quebec and Labrador ranges. Since the richest deposits were mined first, most of the ore now mined is of a type called "taconite" which is a hard rock containing 23 to 25 percent iron. In order to reduce the high cost of shipping waste material to steel plant sites, such ore is "beneficiated," i.e., upgraded, at or near the mine site. The most common method of beneficiation is through pelletization of the ore. Raw, iron-bearing ore is crushed and pulverized, and the iron-rich particles are separated by magnetic separators. The recovered material, approximately 66 percent pure iron, is concentrated into pellets before shipping. Pellets are the major "agglomerated" product.

Most of the iron ore consumed in the U.S. is in the form of pellets. About 2,015 pounds of iron ore is consumed per net ton of steel produced. Treatments similar to pelletization, but more complicated and including chemical treatment of the materials, are being developed to "direct-reduce" iron ore to very highly concentrated pellets or briquettes that are approximately 90 percent iron. These concentrates are so rich that some of them have been fed directly into electric steelmaking furnaces or BOFs, eliminating the need for a scrap change. The amount fed directly into steelmaking furnaces in the last 5 years, however, has been a fraction of 1 percent. This is an emerging technology, and consumption of direct-reduced ore is expected to increase from today's negligible levels to about 10 million tons annually by the year 2000.

The transportation and handling of iron ore and "agglomerates," as the beneficiated materials are known, create many very fine particles. "Fines" cannot be fed directly into blast furnaces. These are mixed with powdered coal and limestone and fused into a cake that is then broken up into pieces suitable for charging blast furnaces. This "sinter" is usually produced at the location of the blast furnace.

Coke--Coal supplies more than 80 percent of the steel industry's heat and energy requirements. A small portion of the coal used is burned to produce steam for electricity generation and other purposes, but about 95 percent is used in coke ovens. Historical coal consumption is shown in Table III-2. About 760 pounds of coke is consumed for every net ton of steel produced. In 1979, the iron and steel industry consumed 71.7 million tons of coal, 69.4 million tons of which went to produce 48.5 million tons of coke.

Coal of coking quality is mined in numerous states, but West Virginia, Pennsylvania, Kentucky and Alabama account for about 80 percent of the steel industry's supply. Other important coal producing states are Ohio, Illinois, Indiana, Utah and Virginia. Because it originates in these locations, little of the metallurgical grade coal shipped to the Great Lakes region steel plants travels on the GL/SLS system. There are, however, significant movements via the Great Lakes from Lake Erie to Canadian steel mills at Sault Ste. Marie, Nanticoke, and Hamilton, Ontario.

TABLE III-2
Coal Consumption by the U.S. Iron and Steel Industry
(Thousands of Net Tons)

Year	In Production of Coke	Steam*	Other Purposes	Total
1979	69,437	2,006	245	71,688
1978	64,562	2,634	285	67,480
1977	69,806	3,048	281	73,135
1976	77,027	2,748	296	80,071
1975	75,515	2,737	364	78,616
1974	81,567	3,426	534	85,527
1973	85,586	4,199	579	90,364
1972	77,081	3,964	400	81,445
1971	74,819	4,358	269	79,446
1970	87,209	4,751	319	92,279

* Includes coal consumed in generating electric power.

Source: Annual Statistical Report, 1979, American Iron and Steel Institute.

Limestone/Lime--In the 5 years from 1975 to 1979, the U.S. steel industry consumed about 27 million tons of limestone and lime each year. In 1979, about 70 percent of this was limestone, while the balance was lime.

About 400 pounds of limestone and lime are consumed per net ton of steel produced. Lime is a product of limestone itself. To derive lime from the limestone, carbon dioxide is drawn off by high temperatures in either vertical or horizontal rotary kilns. Most states have limestone deposits, but much of that used by the steel industry comes from Michigan, Pennsylvania, and Ohio.(2)

Limestone is used in several steps of the steelmaking process. It is used in the sintering process for beneficiation of iron ore fines for use in blast furnaces. The largest use is a purifying agent (flux) for ironmaking in blast furnaces, with a small quantity being used in steel furnaces. Lime is used in steelmaking furnaces as a flux. Consumption of flux materials is shown in Table III-3.

TABLE III-3
Consumption of Fluxes
(Net Tons)

	Fluorspar	Limestone	Lime	Other Fluxes	Total
1979					
In agglomerated products		8,210,243			8,210,243
In blast furnaces		8,989,817			8,989,817
In steelmaking furnaces:					
Open hearth	75,155	739,523	277,185	247,116	1,338,929
Basic oxygen process	386,683	347,013	6,773,113	814,655	8,321,464
Electric	99,926	235,041	1,139,636	102,828	1,577,431
Total	561,764	18,521,637	8,189,884	1,164,599	28,437,884
1978	569,717	18,551,612	8,300,500	1,169,446	28,591,275
1977	506,353	18,765,973	7,293,073	1,135,080	27,700,479
1976	586,486	20,008,416	7,648,689	1,290,356	29,533,947
1975	534,427	20,142,144	7,110,001	891,533	28,678,105
1974	643,976	25,944,018	7,953,915	1,100,097	35,642,006

Source: American Iron and Steel Institute.

The purifying functions of limestone or lime in iron and steelmaking are the same. Basically, the limestone or lime combines with the undesirable minerals in the iron ore. This mixture of limestone/lime and the waste materials is called "slag." Being lighter than iron or steel, the slag floats on top of the molten metal and can be separated from the purer iron or steel.

Scrap--Although not technically a "raw" material in the sense that it does not come directly from nature, scrap steel is itself an important input to the steelmaking process. While the ratio of scrap to pig iron is 45:55 in open hearth furnaces, the ratio of scrap to pig iron for BOFs has been slightly less than 30:70 in recent years. Electric furnaces use almost exclusively scrap; only about 2 percent of the metal input is pig iron.

There are three basic sources of scrap. Steel plants themselves produce large quantities of "home scrap," the trimmings from steelmaking or steel-finishing processes. "Prompt industrial scrap" is steel returned to the steelmaker by a customer after he has shaped his product. "Dormant scrap" is junkyard-type scrap recovered from used end products.

Annual consumption of scrap steel by the American steel industry and the proportions of scrap to pig iron are shown in Tables III-4 and III-5.

TABLE III-4
Consumption of Scrap by the U.S. Steel Industry

Year	Millions of Net Tons
1979	77.2
1978	76.3
1977	69.3
1976	68.4
1975	62.8
1974	81.1
1973	82.5
1972	73.4
1971	63.7
1970	69.3

TABLE III-5
Consumption of Scrap and Pig Iron by Type of Furnace
(Millions of Net Tons)

	Scrap	%	Pig	%	Total
Open Hearth	10.4	45%	12.9	55%	23.3
Basic Oxygen Process	26.5	28	68.5	72	95.0
Electric	34.8	99	0.5	1	35.3
Blast & Other	5.5	67	2.7	33	8.2
Total	77.2	48%	84.6	52%	161.8

Source: American Iron and Steel Institute.

2. Furnace Type

The blast furnace is used in ironmaking. The blast furnace produces pig iron, most of which is used to make steel, a small proportion of which (about 6 percent) is sold as "merchant pig" for use in cast iron products.

Once started up, a blast furnace can operate continuously for years. Iron ore and other iron-bearing materials, coke, and limestone are charged into the furnace from the top and work their way down, becoming hotter as they sink into the body of the furnace which is called the stack. In the top half of the furnace, gas from burning coke removes a great deal of oxygen from the iron ore. About halfway down, limestone begins to react with impurities in the ore and the coke to form a slag. Ash from the coke is absorbed by the slag. Some silica in the ore is reduced to silicon and dissolves

in the iron as does some carbon in the coke. At the bottom of the furnace, where temperatures rise well over 3,000° Fahrenheit, molten slag floats on a pool of molten iron which is four or five feet deep. Because the slag floats on top of the iron, it is possible to drain it off through a slag notch in the furnace. The molten iron is released from the hearth of the furnace through a tap hole.(2) The blast furnace gets its name from the continuous blast of superheated air which is injected near the bottom of the furnace to help combustion of the coke while also contributing to the desired chemical changes.

Because of the need to constantly charge the blast furnace, seasonal and weather-related interruptions of transportation services, and the risk of labor interruptions in the system, large stockpiles of these iron ore feeds are kept by blast furnaces. According to the American Iron and Steel Institute, these stockpiles normally hold a supply of about three to four months.

The proportion of steel being produced by the three major types of furnaces in use today has been rapidly evolving, as illustrated in Table III-6.

The basic oxygen process, employing the basic oxygen furnace (BOF), has become the dominant type of steel production in the United States. BOF steel production passed open hearth output in 1970. The primary inputs to a BOF are molten iron, scrap, lime and oxygen. Iron and scrap are used in varying proportions, with total input about 15-20 percent greater than steel output. A BOF may produce up to 300 tons in 45 minutes as opposed to an open hearth which would take 5 to 8 hours. The basic oxygen process technology is quite new, and only started coming into usage in the U.S. in the mid-1950s.

The first open hearth furnaces in the United States were built in the late 1800s. Although their relative importance to the steel industry has declined drastically in the past two decades, they still provide a significant amount of the country's steel capacity. Their greatest attraction is that they can theoretically use either 100 percent pig iron or 100 percent scrap as their basic metal charge, although most usually use about half and half. The BOF, however, is much more efficient, using only 0.5 million BTUs of energy per ton, compared to 3.5 million BTUs per ton for the open

TABLE III-6
United States and Canada Steel Production

UNITED STATES STEEL PRODUCTION
1970-1979
(*Thousands of Net Tons*)

Furnaces	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Open hearth	94,779	48,022	35,559	34,936	39,780	35,499	22,161	23,470	20,043	21,310	19,158
Basic oxygen process	22,879	63,330	63,943	74,584	83,260	81,552	71,801	79,918	77,408	83,484	83,256
Electric	13,804	20,162	20,941	23,721	27,759	28,669	22,680	24,612	27,882	32,237	33,927
TOTAL	131,462	131,514	120,443	133,241	150,799	145,720	116,642	128,000	125,333	137,031	136,341

Source: American Iron and Steel Institute.

CANADA STEEL PRODUCTION
1970-1979
(Thousands of Net Tons)

Furnaces	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Open hearth	10,433	10,266	5,165	4,608	3,776	3,394	3,275	3,174	3,339	3,632
Basic oxygen process	*	*	5,601	7,434	8,106	8,052	8,759	8,767	9,275	10,048
Electric	1,662	1,698	2,307	2,713	3,135	2,911	2,615	3,085	3,809	4,043
TOTAL	12,095	11,964	13,073	14,755	15,017	14,357	14,649	15,026	16,423	17,723

* Included with open hearth.

Source: American Iron and Steel Institute.

hearth. The BOF requires less than half of the manhours per ton that are required by an open hearth furnace.

Electric arc furnaces, until recently, have been used mainly for specialty alloy steels, have been of small size, and were fed only scrap iron and steel. Today, many electric furnaces are of a size comparable to BOFs, and have realized economies of scale that have made them much more efficient. Although most electric furnaces will use only steel scrap, some are now charged with pig iron and some have used direct-reduced iron of very high purity (well over 90 percent).

3. Iron and Steel Products

There is an extremely large number of steel mill products. Major product categories are identified in Table III-7.

TABLE III-7
1979 Steel Shipments by Product Type
(Thousands of Net Tons)

Steel Products	Subgroups	Groups	Percent of 1979 Shipments
Total Semi-Finished		5,496	5.5
Structural Shapes	5,303		
Steel Piling	293		
Plates	9,035		
Total Shapes and Plates		14,631	14.6
Total Rails and Accessories		2,026	2.0
Total Bars and Tool Steel		17,601	17.6
Total Pipe and Tubing		8,242	8.2
Total Wire and Wire Products		2,449	2.4
Tin Plate	4,604		
Other Tin Mill Products	1,706		
Total Tin Mill Products		6,310	6.3
Hot Rolled Sheet	15,995		
Cold Rolled Sheet	17,284		
Galvanized Sheet and Strip	6,342		
Other Sheet and Strip	3,886		
Total Sheet and Strip		43,507	43.4
Total Net Shipments		100,262	100.0

Source: American Iron and Steel Institute.

Semi-finished steel comprises ingots and steel castings, blooms, slabs, billets, sheet bars, skelp and wire rods. All these products are meant to be further processed before being used in finished products. Wire rods made up a little more than half (52 percent) the total of this group in 1979. As the name implies, this product is destined to be drawn through dies in the manufacture of wire. Most of the rest of the group (38 percent) is comprised of blooms, slabs, billets, and sheet bars. These products are essentially blocks of steel in varying dimensions that will be reshaped into a large variety of more refined forms.

Structural shapes are basically the steel beams and joints used in the construction of bridges, industrial structures, and high-rise buildings. Steel plate can vary in thickness from over one foot to under 1/4 inch. One of its major uses is in shipbuilding, and the decline of that market some years ago was the major cause of the extreme overcapacity problems of the Japanese steel industry. Another major use is in the fabrication of large diameter steel pipe for pipelines. Steel plate is also employed extensively in bridge construction, nuclear power plants, high pressure containers, and many other applications.

In 1979, the consumption of steel in rails and accessories, including wheels, was about 2 percent of production. This percentage has remained constant over the past decade.

Normally, a little more than half the total bars and tool steel shipped in recent years have been hot rolled bars. Bars are made from billets which are heated enough to make them malleable, then run through bar mills. Bar is used in making tools, automobile parts, and many other machinery parts. The other major bar product is reinforcing bars, often referred to as re-bar, used in reinforcing concrete construction.

Pipe and tubing products go to a large variety of uses. "Oil country goods"--casing, drill pipe and oil well tubing--have accounted for about 30 percent of total pipe and tubing in recent years, and may account for a larger share in the near future.

Wire and wire products have an immense number of uses, over 100,000 according to the American Iron and Steel Institute, including nail and staples, woven strands for cables, wire fence, and baling wire.

Total tin mill products are made up mostly (about 75 percent) of "tin plate," i.e., sheet steel with a thin layer of tin applied to it. The primary use for this product is "tin" cans for canning of food and beverages.

Steel sheet and strip products have comprised roughly 45 percent of total steel shipments in the past several years. Of total net shipments in 1979, hot rolled sheet, cold rolled sheet, and galvanized sheet and strip were 16.0, 17.2, and 5.8 percent, respectively. Hot rolled sheet or strip starts with a slab that has been heated to about 2,200°F, which is then run through a series of rolling mills until it reaches the desired dimensions. Much hot rolled sheet is shipped as a finished steel mill product, but much of it also goes to be further processed as cold rolled sheet or to be galvanized. Cold rolled sheet is made by feeding hot rolled sheet through special mills to make a product that is thinner, smoother, and with a higher strength-to-weight ratio than can be made on a hot mill. Hot or cold rolled sheet and strip can be galvanized by two major methods: the hot-dip process, or electrogalvanizing. As implied by the names, the first process involves dipping the sheet or strip in a pool of molten zinc, while electrogalvanizing involves application of the zinc by means of an electric current.

(2) Production Centers

Steel production data tabulated by the American Iron and Steel Institute classify production into 12 regional areas, as shown in Table III-8.

About 70 percent of American steel capability and production are in the districts using the Great Lakes for transportation of raw materials. "Capability" is defined by the American Iron and Steel Institute as "tonnage capability to produce raw steel for a full order book considering the current availability of raw materials, fuels and supplies and of the industry's coke, iron, steelmaking, rolling and finishing facilities and recognizing current environmental and safety requirements."

The Canadian steel industry is highly concentrated in the Province of Ontario. About 70 percent of the country's steel capacity in 1977 was represented by only three companies located in Sault Ste. Marie and Hamilton,

TABLE III-8
Production Data for U.S. Steel Production Districts
(Thousands of Net Tons)

	1979	Total Annual Capability	Percent Capability Utilization
North East Coast	15,607	20,406	76.5
Buffalo*	3,993	4,480	89.1
Pittsburgh*	23,986	29,665	80.9
Youngstown*	8,137	10,605	76.7
Cleveland*	8,544	22,100	38.7
Detroit*	10,856	12,832	84.6
Chicago*	32,495	41,985	77.4
Cincinnati*	5,645	7,440	75.9
St. Louis	4,426	5,500	80.5
Southern	12,459	15,270	81.6
Western	8,681	11,711	74.1
Total	134,829	181,994	74.1

* District in the Great Lakes area.
Source: American Iron & Steel Institute.

Ontario. These companies have the only viable fully-integrated steel complexes in Canada. "Fully-integrated" refers to a steel complex which includes coke ovens, iron-making facilities (i.e., blast furnace), and steelmaking furnaces. Non-integrated plants usually only have electric furnaces. Sydney Steel Corporation, owned by the Province of Nova Scotia, operates another fully-integrated steel mill in Nova Scotia. The distribution of steelmaking capacity in Canada is given in Table III-9.

TABLE III-9
Location of Canadian Steel Plants

	Number of Mills		Capacity	
	Integrated	Non-integrated	(1000 tons)	Percent
Nova Scotia	1	-	990	5.4
Quebec	-	5	1,390	7.6
Ontario	3	4	14,670	80.1
Manitoba	-	1	195	1.1
Saskatchewan	-	1	550	3.0
Alberta	-	2	310	1.7
British Columbia	-	1	200	1.1
	4	14	18,305	100.0

Source: Canadian Ministry of Industry, Trade, and Commerce, Report of the Consultative Task Force on the Canadian Iron and Steel Industry.

(3) Steel Mills in the Great Lakes Area

The steel mills in the Great Lakes area are fairly concentrated geographically. Table III-10 gives a summary of the major districts.

TABLE III-10
U.S. Steel Plants in the Great Lakes Area

District	Number of Facilities	Total Steel Capacity (1000 tons) O.H.	BOF	Elec
Buffalo	12	-	3,800	680
Pittsburgh	30	8,700	16,175	4,490
Youngstown	13	N/A	7,028	3,577
Cleveland	6	-	20,400	1,700
Detroit	6	-	10,112	2,720
Chicago	25	4,200	30,050	7,735
Cincinnati	10		6,300	1,140

Source: DRI, The Iron and Steel Industry Distribution System, 1979.

Most of the facilities are located on or around Lake Erie, with the exception of Chicago, Cincinnati, and Pittsburgh. The Cincinnati and Pittsburgh areas receive ore by rail from Lake Erie ports.

In Canada, there are only three significant steel plant locations in the Great Lakes area: Hamilton, Nanticoke, and Sault Ste. Marie. Dominion Foundries and Steel Co., Ltd. (Dofasco) and Steel Company of Canada Ltd. (Stelco) both have major facilities at Hamilton, Ontario. Algoma Steel Co., Ltd. has a large complex at Sault Ste. Marie, Ontario.

Stelco also has a brand new "greenfield" plant at Nanticoke on Lake Erie. The term "greenfield" refers to a facility started at a new location where no infrastructure previously existed. Stelco's Nanticoke plant, which started up in 1980, is the first such facility to be established in North America in decades, and the last expected one for at least the rest of this century.

Capacity, production and shipments in Canadian Great Lakes locations are shown in Table III-11. Other steel-making plants in Ontario have only electric furnaces and would therefore not receive iron or coal shipments.

TABLE III-11
Canadian Capacity, Production and Shipments
(Thousands of Tons)

	1979	1980	1981
At Sault Ste. Marie			
Capacity	3,525	4,200	4,200
Production	3,525	3,225	3,300
Shipments	2,600	2,340	2,420
At Hamilton			
Capacity	10,050	10,050	10,050
Production	9,920	9,580	8,900
Shipments	7,510	7,130*	7,400*
At Nanticoke			
Capacity	0	300	1,200
Production	0	300	1,200
Shipments	0	300*	1,200*

* Until 1983, all raw steel produced by Stelco at Nanticoke will be shipped by land to Hamilton (about 35 miles) for finishing.

Source: Jones, Heward & Co. Ltd., Montreal.

Stelco's new plant will have an initial capacity of over a million tons. This is expected to expand to 2.8 million tons by 1985 and an eventual level of over 6.0 million tons of raw steel capacity. The timing of expansions will obviously depend on market and economic conditions. It is the hope of Stelco to export a major part of this plant's output to U.S. markets. This objective should be achievable without dumping because of the efficiency of the new plant and its proximity to U.S. markets.

2. INDUSTRY OUTLOOK

This section examines expected growth rates of steel capacity and production, changes in technology and furnace mix, and trends in imports and exports.

(1) Capacity and Production

No new greenfield integrated steel plants are expected to be built in the United States in the next 20 years. Capacity will be expanded in place, in addition to existing facilities, and in new electric furnaces. A forecast of raw steel production is presented in Table III-12. It is expected that capability utilization of raw steel production will reach about 91 percent by the year 2000, an increase from the current utilization level of about 80 percent.

TABLE III-12
Forecast Raw Steel Production

	(Million Tons)				Growth Rate		
	1979	1985	1990	2000	1979-1985	1985-1990	1990-2000
North East Coast	15.6	15.2	17.6	18.2	-0.5%	3.0%	0.4%
Buffalo	4.0	4.3	4.9	5.6	1.3%	2.4%	1.4%
Pittsburgh	24.0	25.2	28.5	32.8	0.8%	2.5%	1.4%
Youngstown	8.2	7.3	8.2	9.4	-1.8%	2.2%	1.4%
Cleveland	8.7	8.8	10.1	11.3	0.3%	2.6%	1.2%
Detroit	10.9	11.6	13.1	15.1	1.1%	2.4%	1.4%
Chicago	32.6	34.5	39.2	45.2	1.0%	2.6%	1.4%
Cincinnati	5.7	6.0	6.8	7.8	1.1%	2.4%	1.4%
St. Louis	4.4	54.	6.1	7.0	3.5%	2.3%	1.4%
Southern	12.7	13.2	14.7	16.8	0.6%	2.1%	1.4%
Western	8.7	8.6	9.9	11.3	-0.2	2.8%	1.4%
TOTAL	135.5	140.1	159.1	180.51			

Source: DRI, The Long-Term Outlook for the U.S. Steel Industry, 1980.

(2) Technology

The basic technological changes in the steel industry in the foreseeable future include the phase-out of open hearth furnaces, the direct reduction of iron ore becoming a major factor, and the increased use of continuous casting methods. Continuous casting refers to the direct production of slabs or billets, bypassing the traditional technology of making ingots and then reshaping them. Continuous casting is a much lower cost procedure.

Open hearth furnaces are very inefficient compared to either BOFs or electric furnaces. The large electric furnaces now being built can make steel on a basis that is

cost-competitive with BOFs and have a lower capital cost than the blast furnace/BOF combination. However, the price of scrap steel, which is the major input to electric furnaces, is very volatile and there is a danger of shortages. This danger would be exacerbated by a multiplication of electric furnace capacity that depended on scrap.

A forecast of production by furnace type is given in Table III-13. By the turn of the century it is expected that open hearth production will be negligible, and electric furnaces will provide about 40 percent of steel production.

TABLE III-13
Expected Change in U.S. Furnace Type
(Steel Production in Millions of Tons)

	1979*	1980	1985	1990	2000
BOF	83.3	72.1	90.4	98.6	103.2
Electric	33.9	30.6	40.6	54.1	74.9
Open hearth	19.2	13.1	10.0	7.0	3.5

* Actual

Source: DRI, The Long-Term Outlook for the U.S. Steel Industry, 1980.

Since many electric furnaces can be charged with steel scrap only, there is a possibility that a shortage of steel scrap might develop in the future.

It is expected that consumption of direct-reduced ores will increase from about 0.5 million tons in 1979 to 10 million tons in the year 2000.(1) The direct-reduced iron would be used primarily as "sponge" iron in electric furnaces, but potentially in blast furnaces as well to increase productivity and reduce the coke rate.

(3) Imports and Exports

Waterborne imports to the Great Lakes of iron and steel products in recent years, shown in Table III-14, have been mostly from overseas. These imports are equal to 18.5 percent of total iron and steel imports to the United States during this 5-year period. Total imports of steel mill products (not including other steel products, iron products and ferroalloys, which would add about 15 percent in volume) averaged 15.7 percent of apparent supply in the last 5 years according to the American Iron and Steel Institute. Imports are expected to comprise 20 percent of total consumption by the year 2000.(1) This would total about 34 million tons.

TABLE III-14
Iron and Steel Imports to the Great Lakes

Origin	1978	1977	1976	1975	1974
Canada	267	184	93	211	248
Overseas	3,756	5,085	2,652	2,096	2,738

Source: Waterborne Commerce of the United States.

Imports are expected to take a larger share of the total domestic market in the future, rising from around 16 percent of consumption currently to 20 percent by the year 2000. At the same time, exports are forecast to decline from about 3.0 million tons per year now to only 1.0 million tons two decades from now. Table III-15 shows the expected trend of imports and exports.

TABLE III-15
U.S. Imports and Exports of Steel
(Millions of Tons)

	1979*	1980	1985	1990	1995	2000
Imports	17.2	15.2	20.6	25.6	29.2	34.1
Exports	2.8	3.0	2.0	1.3	1.1	1.0

* Actual

Source: DRI, The Long-Term Outlook for the U.S. Steel Industry, 1980.

3. ALTERNATIVE SUPPLY SOURCES AND DISTRIBUTION SYSTEMS

This section discusses the sourcing of iron ore and imported steel products, iron ore movements, and the captive ownership aspects of raw material supplies and transportation equipment.

(1) Iron Ore Sources

Recoverable iron ore reserves in the world today would satisfy recent production levels for over 300 years. The iron ore deposits of the Lake Superior ranges are essentially the sole U.S. source of iron ore and agglomerates for American steel plants in the Great Lakes hinterland. The rest of the iron ore used comes either

from the Canadian Lake Superior region or the Quebec/Labrador range. According to the Bureau of Mines, proven economic reserves for the operating mines around Lake Superior vary from about 40 to 100 years. These proven economic reserves total about 16 billion tons of ore--good for 70 years of pellets at the current consumption rate. Actual, but not yet "proven," reserves in the area are much greater.

By far the most important source of U.S. Great Lakes region iron ore is the Mesabi range of northern Minnesota. In 1979, 76.7 percent of iron ore shipments originating in the U.S. Great Lakes area came from the Mesabi range. In the past five years, 75.8 percent of total ore destined to the Great Lakes from Great Lakes ports has been loaded at the ports on the north shore of Lake Superior in Minnesota.(3) There is no reason to anticipate major raw material sourcing changes in the foreseeable future.

For the past several years, Canada has supplied well over half the total iron ore imports of the United States, and all the imports to the Great Lakes area. Other significant sources of imports are Brazil, Liberia and Venezuela. These imports from other countries, however, have gone primarily to coastal areas. Some of this non-Canadian imported iron ore has reached the Great Lakes area, moving by rail from Baltimore and Philadelphia in particular, mostly to the Pittsburgh area.

Table III-16 shows a recent history of the iron ore shipments to the Great Lakes area.

TABLE III-16
U.S. and Canadian Ore Shipments Destined to the Great Lakes

Origin	1975	1976	1977*	1978	1979
Canada-Great Lakes	5.5	5.6	6.5	5.4	4.0
Canada-Eastern	12.2	17.9	19.1	12.1	13.3
Total - Canada	17.7	23.5	25.6	17.5	17.3
Total - U.S.	62.6	63.1	41.5	71.3	74.7
Total Ore to Great Lakes	80.3	86.6	67.0	88.9	92.0
(Percent Canadian Sourced)	(22.0%)	(27.1%)	(38.2%)	(17.7%)	(18.8%)

* There was a mine strike in 1977.

Source: American Iron Ore Association, Iron Ore, 1979.

Shipments by port vary significantly from year to year, as shown in Table III-17. The fluctuations from 1976 to 1978 were caused by a prolonged strike at the American mines in 1977. There is no indication that there is any important quality differentiation between Canadian and American ores, especially when beneficiated. The factors influencing sourcing are economics, availability, transportation infrastructure, and captive ownership.

A stabilizing factor in the sourcing of iron ore is the proprietary ownership of mines and Great Lakes vessels by the steel companies. Both American and Canadian steel producers own major raw material sources, both iron and coal as well as limestone and other smaller volume mineral requirements. This aspect is discussed further in the following section.

(2) <u>Captive Ownership</u>

Captive ownership of raw material sources and transportation equipment and infrastructure is a major factor in the iron and steel industry. Most of the iron mines are owned by steel companies--either individually, jointly, or in consortia. The Bureau of Mines puts current maximum capacity of the mines in the Lake Superior ranges at about 85 million tons--almost all pellets and fines. Of this total, U.S. Steel alone owns over 20 percent, with other major holdings by Inland Steel, Armco, Republic, Bethlehem, and the Canadian companies. The Bureau of Mines estimates that about 80 percent of the ore mined is done either by or for the account of the steel companies.

There are about 140 American bulk carriers operating on the Great Lakes, most of which transport ore. Like the mines and the railroads that carry the ore from the mines to the Lakes, the lake vessels are predominantly owned by the steel companies. Table III-18 categorizes ownership of the vessels by steel companies, mining companies, shipping companies, and others.

Most of these vessels are about 600 feet in length, with deadweights around 20,000 tons. There are 12 bulk carriers in the 1,000 foot class, with a carrying capacity of around 60,000 tons.

TABLE III-17
Iron Ore Shipments Through Major Great Lakes Ports
(Thousands of Gross Tons)

Shipping Port and Lake	1975	1976	1977	1978	1979
Superior (L. Superior)	6,609	6,145	7,742	12,515	13,674
Duluth (L. Superior)	14,385	14,050	10,687	13,568	15,039
Two Harbors (L. Superior)	8,557	7,506	3,201	9,477	11,124
Marquette (L. Superior)	4,588	5,436	3,990	6,003	5,332
Escanaba (L. Michigan)	9,383	10,061	7,890	11,434	11,816
Silver Bay (L. Superior)	8,971	9,694	4,449	9,610	8,267
Taconite Harbor (L. Superior)	10,114	10,254	3,501	8,752	9,467
Michipicoten (Canada) (L. Superior)	30	74	---	---	---
Depot Harbor (Canada) (L. Huron)	662	622	573	675	227
Little Current (Canada) (L. Huron)	496	375	608	306	---
Picton (Canada) (L. Ontario)	272	451	598	43	---
Thunder Bay (Canada) (L. Superior)	3,976	4,127	4,695	4,395	3,801
Point Noire (Canada) (Labrador)	2,989	5,053	5,108	3,608	5,149
Port Cartier (Canada) (Labrador)	2,968	4,834	3,842	2,592	2,685
Seven Islands (Canada) (Labrador)	6,267	7,965	10,166	5,918	5,473
TOTAL	80,267	86,647	67,050	88,896	92,054

Source: American Iron Ore Association.

TABLE III-18
Ownership of the Great Lakes Fleet

Owner/Charterer	Number of Vessels
Steel Companies	
U.S. Steel	29
Inland Steel	6
Bethlehem Steel	7
Ford Motor Company	5
National Steel (Hanna)	5
Subtotal	52
Mining Companies	
Cleveland Cliffs	10
Interlake (Pickands, Mather & Co.)	11
Oglebay Norton	19
Subtotal	40
Shipping Companies	
American Steamship Company (GATX)	20
Kinsmen Transportation	9
Subtotal	29
Others	
Amoco	3
National Gypsum	6
Cement Transit Company	7
Erie Sand	3
Subtotal	19
TOTAL	140

Source: Lake Carriers Association.

Captive ownership extends also to metallurgical coal. Captive mines of steel concerns produced some 55.6 million tons of coking coal in 1979, which is about 72 percent of coking coal shipments, and equal to 80 percent of the coal used by American iron and steel companies in coke production. Captive steam coal production by utility companies is greater in tonnage (891 million tons in 1979), but much smaller in proportion to total utility coal usage (17 percent). The trend to captive production in utility steam coal is on the increase, however.(4)

Most of the metallurgical coal used by both American and Canadian steel companies in the Great Lakes area comes from West Virginia, Kentucky and Pennsylvania. As noted earlier, because of the location of the sources of the coal, very little moves on the Great Lakes to American steel companies. Most of these movements are by unit train. Coal which moves in domestic trade on the Great Lakes is almost exclusively for utility usage.

The Canadian steel companies, however, get almost all of their metallurgical coal from Appalachia. These movements are by unit train to the ports on the southern shore of Lake Erie, then by laker to Sault Ste. Marie, Hamilton and Nanticoke. Both Dofasco and Algoma have coal mining interests in West Virginia, while Stelco owns all or part of coal mining operations in West Virginia, Kentucky and Pennsylvania.

(3) Distribution Systems

Almost all iron ore and agglomerates shipped to Great Lakes area steel mills travel on the Great Lakes. Some shipments, however, once they reach Lake Erie or Lake Michigan ports, travel further inland by rail. Table III-19 shows the location of integrated steel mills in the Great Lakes region. "Integrated" here means companies with open hearth or BOF, and usually blast furnace capacity. The capacities are split by "on or very near the Lakes" or "inland" classification. The Youngstown and Cincinnati area plants receive almost all their iron ore by rail from Lake Erie, according to the Bureau of Mines. Shipments to Pittsburgh area plants are more complicated. Certainly a significant amount of their ore is from the Lake Superior ranges, but a large amount is imported ore railed from the ports of Baltimore and Philadelphia.

Ore from the mines is railed to the pelletizing plants and loading ports on Lakes Superior and Michigan. A very small amount is moved by rail directly to steel mills.

TABLE III-19
Great Lakes Steel Mill Locations

District	Steel Capacity (000 Tons) On Water	Inland	
Buffalo	3,800	-	
Pittsburgh	-	25,175	(far)
Youngstown	-	7,028	(medium)
Cleveland	10,000	10,400	(close)
Detroit	10,112	-	
Chicago	34,250	-	
Cincinnati	-	6,300	(far)
	49,162	48,903	

Source: DRI, The Iron and Steel Industry Distribution System, 1979.

The Canadian mills are located on the water: Algoma Steel in Sault Ste. Marie at the eastern end of Lake Superior; Stelco and Dofasco in Hamilton at the extreme west end of Lake Ontario; Stelco's new integrated mill at Nanticoke on Lake Erie, directly north of Erie, Pennsylvania. Almost all iron ore is received at these plants by water.

REFERENCES

(1) Data Resources, Inc., The Long-Term Outlook for the U.S. Steel Industry, 1980.

(2) The American Iron and Steel Institute, The Making of Steel.

(3) American Iron Ore Associates, Iron Ore, 1979.

(4) Standard and Poor's Corporation, Steel--Coal Basic Analysis, October 1980.

IV. THE U.S. GRAIN INDUSTRY

IV. THE U.S. GRAIN INDUSTRY

This chapter describes various aspects of the U.S. grain industry, with emphasis on those segments of the industry that are of importance to grain movements on the GL/SLS. Included in the discussion is a description of the supply of grains, grain marketing channels, the transportation of grains to market and export trends of U.S. grains.

The major U.S. grains moving on the GL/SLS are wheat, corn, soybeans, barley and rye. In 1978, about 8 million tons of wheat, 7 million tons of corn, 3 million tons of soybeans and 400 thousand tons of barley and rye moved on the Great Lakes/St. Lawrence Seaway. Because of the importance to lake shipments of these grains compared to other grains produced in the United States, the following discussion of the U.S. grain industry concentrates on these grain types.

1. THE SUPPLY OF GRAINS IS CONCENTRATED IN A FEW STATES

The U.S. production of each of the above-mentioned grains is concentrated in a few states, and the Great Lakes/St. Lawrence Seaway provides an attractive export outlet for several of these states.

In 1979, nearly 70 percent of the total U.S. wheat production was concentrated in eight states, with the three largest state producers responsible for 41 percent of the production. Table IV-1 shows the leading wheat producing states and production for 1977-1979. Corn production is similarly concentrated in a few major producing states. As seen from Table IV-2, seven states have been responsible for about 75 percent of the total U.S. corn production. Five states are responsible for the majority of soybean production, as indicated in Table IV-3. Table IV-4 shows that in 1979, five states produced 67 percent of the total barley produced in the United States. Finally, U.S. rye production is concentrated within five states that have accounted for about 70 percent of rye production between 1977 and 1979. Rye production is shown in Table IV-5.

TABLE IV-1
Wheat Production by Major Wheat Producing States

STATE	PRODUCTION (Millions of Bushels)		
	1977	1978	1979
Kansas	345	306	410
North Dakota	230	286	252
Oklahoma	176	146	217
% of Total for three leading states	37%	41%	41%
Texas	118	54	138
Washington	101	131	118
Montana	131	146	117
Minnesota	132	93	90
Nebraska	103	82	87
Total 8-state production	1,336	1,244	1,429
Total U.S. production	2,036	1,798	2,142
Leading states' share of total U.S. production	66%	69%	67%

Source: Crop Reporting Board, U.S.D.A., Small Grains Annual Summary, December 1979.

TABLE IV-2
Corn Production by Major Producing States

STATE	PRODUCTION (Millions of Bushels)		
	1978	1979	1980
Iowa	1,461	1,626	1,452
Illinois	1,191	1,358	1,039
Indiana	637	664	595
Nebraska	740	794	585
Minnesota	643	606	566
Ohio	379	418	443
Wisconsin	270	307	342
Major Producing State Total	5,321	5,773	5,022
U.S. Total	7,087	7,764	6,461
Leading States' Share of Total U.S. Production	75%	74%	78%

Source: Crop Reporting Board, U.S.D.A., Crop Production, 1980.

TABLE IV-3
Soybean Production by Major Producing State

STATE	PRODUCTION (Millions of Bushels)		
	1978	1979	1980
Iowa	290	310	314
Illinois	308	374	305
Indiana	144	154	152
Minnesota	146	163	146
Ohio	126	147	132
Missouri	158	187	121
Major State Production	1,172	1,340	1,170
Total U.S. Production	1,870	2,268	1,775
Leading States' Share of Total U.S. Production	63%	59%	66%

Source: Crop Reporting Board, U.S.D.A., Small Grains 1979 Annual Summary and 1980 Crop Winter Wheat and Rye Seedings, CrPr2-(2) (79), December 1979.

TABLE IV-4
Major Barley Producers

STATE	PRODUCTION (Thousands of Bushels)		
	1977	1978	1979
North Dakota	99	113	76
Idaho	44	56	49
California	53	46	47
Minnesota	55	52	41
Montana	52	59	41
Major U.S. State Production	303	326	254
U.S. Production	420	449	378
Leading States' Share of Total U.S. Production	72%	73%	67%

Source: Crop Reporting Board, U.S.D.A., Small Grains 1979 Annual Summary and 1980 Crop Winter Wheat and Rye Seedings, CrPr2-(2) (79).

TABLE IV-5
Rye Production by Major Producing States

STATE	PRODUCTION (Thousands of Bushels) 1977	1978	1979
South Dakota	3,480	6,820	6,300
North Dakota	2,080	6,355	5,180
Georgia	1,995	2,530	2,310
Minnesota	2,436	2,352	2,275
Nebraska	1,050	1,007	1,100
Major Producing State Total	11,041	19,064	17,175
U.S. Total	17,312	26,160	24,549
Leading States' Share of Total U.S. Production	64%	73%	70%

Source: Crop Reporting Board, U.S.D.A., Small Grains 1979 Annual Summary and 1980 Crop Winter Wheat and Rye Seedings, CrPr2-(2)(79). December 21, 1979.

2. THE MARKETING OF U.S. GRAIN INVOLVES A COMPLEX SET OF DECISIONS

This section describes the marketing and distribution patterns of U.S. grain, including a description of how the grains move from farms to final consumption and the decision processes involved in marketing the grain.

Generally, grains move from the farms to local country elevators where the grain is stored until further movement to either a rail terminal or a river terminal for transportation. Grain is usually moved from the farm by truck to local country elevators. The movement from country elevators to river or rail terminals is also usually by truck.

There has been an increasing trend toward storage of grain on the farm rather than at the country elevator. For example, farmers currently store over 50 percent of corn production on the farm. This corn is either held for future sale or fed to the farmers' own livestock.

In some cases, the farmer sells the grain to the country elevator and his involvement in the marketing process ends. In other cases, the farmer pays for storage at the elevator but still maintains ownership of the grain, and remains involved in further marketing decisions.

The decision-maker, whether it be the farmer, country elevator operator, or a grain merchant, is faced with a set of alternative decisions as to the marketing of the grain:

- The grain can be sold domestically for milling or feed processing.

- The grain can be sold for export.

- The grain can be held in storage, postponing the decision.

The decision to sell for export or domestic consumption is based on a comparison of the prices obtainable from each marketing option, as well as the cost of transporting grain for either domestic or export consumption. The marketing option offering the most attractive financial reward (selling price less cost of transportation) is the marketing option chosen. The marketing decision thus involves not only the choice of the most favorable market location, i.e., export port or domestic geographic market, but also the choice of the most efficient mode of transporting the grain to market location. Changes in prices at any of the stages in the decision process can result in a change in the choice of market location, transportation mode and ultimate market decision to sell domestically or export.

The distribution between export grain and total production reflects the choice between the marketing decision to sell domestically or to export. Table IV-6 shows this breakdown for the relevant grains. For each grain, the annual production and the amount inspected for export that year are presented. It should be emphasized that the grain exported is not necessarily the grain produced during the year, but also includes grain stored from the previous year.

Several interesting trends can be observed from Table IV-6. The data suggest that over time the percent of corn produced which is exported has increased. The fraction of soybeans and wheat exported has remained fairly constant with the exception of large wheat exports in 1973. The fraction of barley and rye exported has fluctuated widely between 1970 and 1978. The increased share of corn exported has important implications for Great Lakes movements, since corn is the second largest U.S. grain moving on the lakes. On the other hand, exports of rye are declining as the share of rye exported has fallen dramatically from 1973 levels.

TABLE IV-6
Production and Export
(Millions of Bushels)

Calendar Year	Corn For Grain			Wheat			Barley			Rye			Soybeans		
	Production	Export[1]	% Exported	Production	Export[1]	% Exported	Production	Export[1]	% Exported	Prod.	Export[1]	% Exported	Prod.	Export[1]	% Exported
1970	4,099	538	13	1,370	642	47	410	52	13	39	.1	0.2	1,124	433	39
1971	5,540	503	9	1,640	600	37	462	50	11	51	5	10	1,169	428	37
1972	5,573	859	15	1,545	784	51	424	57	13	29	.2	0.7	1,271	440	35
1973	5,647	1,270	22	1,705	1,377	81	422	88	21	26	31	119	1,547	479	31
1974	4,651	1,153	25	1,796	925	52	304	47	15	19	9	47	1,233	505	41
1975	5,829	1,293	22	2,135	1,143	54	383	25	7	18	1.0	6	1,547	456	30
1976	6,266	1,734	28	2,147	969	46	377	56	15	17	.1	.6	1,288	561	44
1977	6,357	1,577	25	2,036	891	44	378	70	19	17	0	0	1,716	593	35
1978	7,087	1,956	28	1,798	1,246	69	449	25	6	26	0	0	1,870	770	41

1. Grains inspected for export

Source: Production data from Crop Reporting Board, USDA, Crop Production Annual Survey, Selected Years.
Export data from Agricultural Marketing Service, USDA, Grain Market News

Given that an export market decision is made, the choice of port becomes a critical decision. The same factors that affect the export versus domestic consumption marketing decision also drive the decision as to which port to select for export of grain. A shipper exporting grain evaluates the transportation cost to each alternative export port and the existing export prices (determined by world demand) at these ports. The port is selected that offers the greatest financial return to the shipper. As relative port export prices and transportation costs to the ports change, shippers in a region select different ports for export. Included in the transportation cost are port costs such as handling charges and storage. Therefore, changes in these costs relative to other port area costs will also affect a shipper's choice of export port.

It is this port selection process combined simultaneously with the export versus domestic consumption decision that affects the traffic movements of grain through Great Lakes ports. The following section describes the U.S. grain movements on the Great Lakes/St. Lawrence Seaway.

3. THE OVERALL SHARE OF U.S. GRAIN EXPORTS THROUGH THE GREAT LAKES/ST. LAWRENCE SEAWAY HAS BEEN DECLINING, DESPITE AN INCREASE IN GRAIN TONNAGE ON THE LAKES

In general, the Great Lakes ports' share of U.S. grain exports has been declining between 1970 and 1978. As Table IV-7 indicates, this declining trend has been characteristic of most of the major grain types, with the exception of wheat. The decline in export share has occurred despite a significant increase in the tonnage of corn and wheat shipped on the Lakes. This increase in Great Lakes/St. Lawrence Seaway corn and wheat movements is shown in Table IV-8. The tonnage movement of barley and rye declined significantly, while soybean movements fluctuated annually.

The majority of the grain movements on the GL/SLS are for export. The largest domestic movement of grains on the Great Lakes is wheat. In 1978, 20 percent of the wheat shipments on the Great Lakes were domestic, primarily to Buffalo for milling purposes. Furthermore, in 1978, 20 percent of the barley and rye movements were domestic.

Several factors are likely to influence the share of grain exports handled by the GL/SLS. The availability of grain, both from new production and stocks from previous years, in states typically supplying GL/SLS ports, is obviously an important factor affecting the movements of grain on the GL/SLS. Therefore, if production levels increase and stocks of grains build in elevators located in such states as Montana, North and South Dakota, Indiana, Illinois, Michigan, Iowa and Wisconsin, export movements through GL/SLS ports would be expected to increase (other factors affecting port choice being the same).

TABLE IV-7
Percent of U.S. Grain Exports Inspected for Shipments Through Great Lakes/St. Lawrence Seaway Ports

	Total	Corn	Wheat	Barley and Rye	Soybeans
	%	%	%	%	%
1970	18	20	9	89	22
1971	18	24	9	44	25
1972	15	19	10	74	15
1973	14	24	10	67	13
1974	9	16	6	45	10
1975	10	12	12	34	13
1976	9	10	6	49	11
1977	11	9	12	62	11
1978	13	9	16	50	12

Source: Agricultural Marketing Service, U.S.D.A., Grain Market News, selected years.

TABLE IV-8
Total Grain Movements on the Great Lakes
(Thousands of Tons)

	Barley and Rye	Corn	Wheat	Soybeans
1971	1,071	3,255	2,961	3,157
1972	1,697	3,683	3,830	1,891
1973	2,403	4,396	5,396	2,001
1974	990	3,147	2,918	1,527
1975	628	3,011	5,386	1,752
1976	947	4,418	3,303	1,791
1977	1,204	4,032	4,673	1,904
1978	426	6,812	7,712	2,836

Source: U.S. Army Corps of Engineers, Waterborne Commerce of the United States, Part 3, 1971-1978.

Secondly, the shifts in relative demand for grains from European countries to Pacific rim countries have an influence as to which port areas the shippers in the supplying states (to the Great Lakes) will use. As world area demand shifts, the relative attractiveness of port areas changes. Ports in the closest proximity to the world area where demand increases will become more attractive compared to other ports, since the total cost of shipping the grain to the final consumption point will most likely be lower using such ports. Similarly, if the grain purchasers pay the ocean freight, the demand for grain will increase at the U.S. export port area closest to the high demand world area. As a result of the increase in demand, the bid price of grain at the closest export port area will increase, attracting grain from other port areas. Therefore, as Pacific rim countries' demand for grain increases, the shippers in the primary supplying states to GL/SLS ports will likely shift their supplies to West Coast ports.

Table IV-9 shows the percentage of exports that has been consumed by Pacific rim countries over time. It appears from these figures that overall grain shipments to Pacific rim countries have been declining. The trend is most notable for wheat and corn. The share of soybean shipments to Pacific rim countries appears to be fairly constant. This decline in the share of exports to Pacific rim countries is consistent with the increased tonnage of corn and wheat shipments on the Great Lakes, as shown previously in Table IV-8. However, conversations with industry experts suggest that the demand by Pacific rim countries will increase in the future, thus increasing the attractiveness of West Coast ports.

Movements of U.S. grains on the Great Lakes are also influenced by vessel availability and cost. Grains are often transported to transshipment points at St. Lawrence ports as a backhaul by laker ore carriers. The ore carriers move ore from the Labrador region to Great Lakes ports for consumption by the steel mills located in the GL/SLS hinterland. After the ore is unloaded, grain is loaded and moved to St. Lawrence River ports. Therefore, as iron ore shipments increase, other factors held constant, grain shipments via the GL/SLS ports are likely to increase.

The combination of these factors tends to increase or decrease the GL/SLS ports' competitive position, with respect to other U.S. port areas. The degree of competition for export grain with other U.S. port areas differs by grain type, and by the location of the supplying grain states. For example, the Great Lakes ports compete with West Coast ports for North Dakota, South Dakota and Montana wheat. Gulf Coast ports compete with the GL/SLS ports for corn and soybeans produced in Minnesota, Indiana, Iowa and Illinois, and for wheat produced in Minnesota. East Coast ports compete with GL/SLS ports for

TABLE IV-9
Percent of U.S. Exports Consumed by
Pacific Rim Countries*

	Wheat %	Rye and Barley %	Corn %	Soybeans %
1970	42.2	4.4	31.4	26.1
1971	35.5	0.5	31.1	26.9
1972	30.7	18.8	19.6	27.4
1973	20.5	36.7	24.7	26.8
1974	31.0	17.7	27.1	26.3
1975	41.0	48.9	20.2	26.1
1976	37.2	9.6	17.2	23.3
1977	25.3	36.2	22.8	25.1
1978	23.4	12.7	23.0	22.3
1979	18.6	1.8	21.5	22.0

* Pacific Rim countries are Hong Kong, Japan, the Philippines, Peoples Republic of China, India and Korea.

Source: Agricultural Marketing Service, U.S.D.A., Grain Market News.

corn and soybeans primarily produced in Indiana, Illinois and Ohio. The increased use of unit trains to West Coast and Gulf Coast ports has recently escalated the competition between GL/SLS ports and these other port areas.

4. FOUR MAJOR PORT AREAS ARE RESPONSIBLE FOR THE SHIPMENT OF GRAINS ON THE GREAT LAKES/ST. LAWRENCE SEAWAY

The primary port areas handling grain on the Great Lakes/St. Lawrence Seaway are the Chicago area, the Duluth-Superior area, the Saginaw area and the Toledo area. The Duluth-Superior area leads the other port areas in terms of total shipments, followed by Toledo, Chicago and Saginaw. As indicated by Table IV-10, Duluth-Superior is the leader in terms of wheat shipments and was also responsible for the barley exports on the Great Lakes in 1979. The Toledo area ports handled the majority of the soybean shipments, while the Chicago area handled the bulk of Great Lakes corn shipments. The port handlings of these grain types are consistent with the proximity of the ports to the producing regions for the particular grain types.*

* The port descriptions are based on conversations with grain experts, grain terminal operators, U.S. Department of Agriculture personnel, and Great Lakes port officials.

TABLE IV-10
Major Great Lakes Port Areas
Handling Export Grains
(1979; Thousands of Bushels)

Port Area	Wheat	Barley/Rye	Soybeans	Corn
Chicago Area[1]	323	------	18,758	118,652
% of GL Shipments	0.2%	---	31%	43%
Duluth Superior Area[2]	134,015	16,580	2,629	51,239
% of GL Shipments	89%	100%	4%	18%
Toledo Area[3]	13,608	------	38,332	101,554
% of GL Shipments	9%	---	62%	37%
Saginaw Area[4]	2,455	------	2,048	6,038
% of GL Shipments	2%	---	0.3%	2%

1. Chicago Area includes Ports of Chicago and Milwaukee, Wisconsin.
2. Duluth-Superior Area includes Ports of Duluth and Superior.
3. Toledo Area includes Ports of Toledo; Huron, Ohio; Erie, Pennsylvania; Buffalo, New York.
4. Saginaw Area includes Ports of Saginaw, Carrollton and Zilwaukee, Michigan.

Source: Agricultural Marketing Service, USDA, Grain Market News.

The majority of grain shipped via Duluth-Superior originates in Minnesota, North Dakota, South Dakota and Montana. Minnesota is the principal supplier of soybeans and corn, and barley and rye are supplied to Duluth-Superior elevators by North Dakota and Minnesota producers. The major grain shipment points to Duluth-Superior are:

- Fargo, North Dakota
- Grand Forks, North Dakota
- Bismarck, North Dakota
- Minot, North Dakota
- Aberdeen, South Dakota
- Crookston, Minnesota
- Wellmar, Minnesota
- Washington, Minnesota
- Fairmont, Minnesota
- Glendive, Montana
- Baker, Montana.

The grains are moved to the Duluth-Superior elevators from these shipment origins either by rail or truck. In 1980, rail carried 60 percent of the grains delivered, with trucks carrying the balance. In the previous year, trucks carried the majority of grains to the Duluth-Superior area. The split between rail and truck is heavily dependent on the availability of rail cars from the major lines connecting grain supply points with Duluth-Superior. These major lines are the Burlington Northern, Soo and Milwaukee railroads. While trucks have been used to transport grain from up to 700 miles to Duluth-Superior, the tendency has been toward more rail deliveries with unit train rates.

When the St. Lawrence Seaway is closed in the winter, grains usually move from hinterland points by unit train to West Coast or Gulf Coast ports. Very little grain is moved to Duluth-Superior elevators in the winter months.

Grains are stored at the eight elevators located at Duluth. These elevators are owned by:

- International Multifoods
- Cargill
- Continental Grain
- Grain Terminal Association
- Farmers Union
- General Mills
- Peavey
- Conagra
- Arthur Daniels & Co.
- Midland.

In addition, Italgrani has recently purchased two elevators at the Duluth-Superior port area and will begin operations shortly. Louis Dreyfus & Co. will open an elevator in 1982.

The grain moves on the lakes from Duluth-Superior via both ocean vessels and lakers. The major destination countries for export grain loaded into ocean vessels are the Netherlands, Venezuela, Germany, Algeria and Russia. The lakers are primarily Canadian flag, which take the grain to St. Lawrence River ports where it is transshipped to oceangoing vessels for export. The lakers are sometimes ore vessels bringing Labrador ore to lake ports.

The Toledo port area receives corn, soybeans and wheat primarily from Ohio, Michigan and Indiana. The grain is supplied to the port both directly from farms as well as from country elevators. Major grain shipping nodes in the Toledo hinterland are:

- Kalamazoo, Michigan
- Adrian, Michigan
- Albian, Michigan
- Lagrange, Indiana
- Paulding, Ohio
- Napoleon, Ohio.

Nearly all grain shipments (97 percent in 1980) to the port are via truck. Three major lakefront elevators serve the Toledo area. These elevators are owned by:

- Anderson
- Cargill
- Mid States.

More than half of the grains shipped from Toledo are carried by Canadian-owned lakers to St. Lawrence River transshipment points. The movements by lakers are sometimes the backhaul leg of Labrador iron ore deliveries to Toledo. Other movements are by lakers strictly engaged in the grain trade. The major destination countries for export grain loaded into ocean vessels are the United Kingdom, Germany and Belgium. In addition to Toledo's importance as a Great Lakes port in the shipment of grain, Toledo elevators are serviced by unit trains moving grain to East Coast and Gulf Coast ports. Hence, even in winter, when the Seaway is closed, grains from Indiana, Ohio and Michigan are shipped to the Toledo elevators. From these elevators unit trains transport the grain to the most attractive markets.

The Port of Chicago receives soybeans and corn primarily from Indiana, Illinois and Iowa. In addition, producers in southern Wisconsin and eastern Kansas occasionally ship grain

through Chicago. The supplying areas are usually located within a 150- to 200-mile radius of the Port of Chicago. Grains in this area are moved to Chicago primarily via truck. In 1980, trucks were responsible for 78 percent of the deliveries of grain to Chicago, rail moved 17 percent of the deliveries, and barge supplied the remaining 5 percent. Since Chicago's drawing area is within a 150- to 200-mile radius, the major market decision of supplying producers is to sell the grain either domestically to the local broiler market, or for export either by the lakes via Chicago or by unit train to East Coast ports.

Four elevators are located at the Port of Chicago. These are owned by:

- Cargill
- Continental Grain (2 elevators)
- Indiana Grain Co-op.

The major destination countries for export grain loaded into ocean vessels at Chicago are Russia, the United Kingdom and Italy. Lakers also move grain to Canadian ports on the St. Lawrence Seaway for transshipments to final export destinations.

As with Toledo, Chicago continues to draw some grains from its hinterland in the winter when the navigation season is closed. These grains are then shipped via rail to the most profitable market--domestic or export--via Gulf Coast or East Coast ports.

The Port of Saginaw receives the majority of its grain from a somewhat captive area in Michigan. Corn, wheat and soybeans are shipped to Saginaw from such areas as:

- Flint, Michigan
- Grand Rapids, Michigan
- Standish, Michigan.

Because of the relatively small drawing area for Saginaw, most grains move to the port by truck from the farms and country elevators. There has been an increase in rail movements, but transport via this mode is dependent on rail car availability.

At the port of Saginaw, two elevators are available. These are owned by:

- Wicks Agriculture
- Farm Bureau.

The majority of grain shipped from Saginaw is transshiped at St. Lawrence River ports.

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V. THE GRAIN INDUSTRY OF CANADA

V. THE GRAIN INDUSTRY OF CANADA

This section describes the grain industry of Canada, including a description of grain supply, grain marketing channels and traffic moving on the Great Lakes/St. Lawrence Seaway.

1. THE SUPPLY OF GRAINS IS CONCENTRATED IN THE PRAIRIE PROVINCES

The prairie provinces are responsible for the production of the majority of Canadian grains. These provinces are Manitoba, Alberta and Saskatchewan. Saskatchewan is the largest producer, followed by Alberta and Manitoba. Six major types of grain are produced in these regions:

- Wheat (including Durum)
- Oats
- Barley
- Rye
- Flaxseed
- Rapeseed.

Wheat and barley are the major Canadian grain movements on the Great Lakes/St. Lawrence Seaway and hence the analysis concentrates on these two grain types.

Table V-1 shows the production of these grains for the 1970-1979 period. The data in the table indicate that

TABLE V-1
Grain Production in Canada

Crop Year	Wheat (1,000 metric tons)	Rye (1,000 metric tons)	Barley (1,000 metric tons)
1970	8,557	1,214	8,448
1971	13,970	567	12,571
1972	14,033	447	10,812
1973	15,704	493	9,798
1974	12,707	351	8,391
1975	16,370	444	9,051
1976	22,812	277	10,087
1977	18,898	653	11,380
1978	20,624	572	9,847
1979	18,846	836	7,899

Source: Canadian Wheat Board, *Annual Report*.

production of wheat in Canada has followed an upward trend since 1970, and that barley production has fluctuated widely over the 10-year period.

2. THE MARKETING AND TRANSPORT OF CANADIAN GRAIN ARE CONTROLLED BY THE CANADIAN WHEAT BOARD

The Canadian grain market channels differ significantly from those in the United States grain industry. The U.S. grain industry is characterized by a large number of independent producers and buyers; market decisions are highly responsive to price changes. In contrast, the marketing of all Canadian grain is handled by the Canadian Wheat Board (CWB), a division of the Canadian Government.

The Canadian grain-producing provinces are divided into 48 producing blocks. The CWB assigns quotas, by type and grade of grain, to each block according to the type and grade of grain on the farms in each block. It is through this quota system that grains flow from the producers to the primary elevators and eventually to the final destination, i.e., export or domestic consumption.

The Canadian Wheat Board is responsible for marketing the grain produced in the producing blocks,* assigning the quotas in each block and regulating the transportation of grain from each block to the primary elevator. The typical flow of grain occurs as follows. The CWB determines the grain requirements at the different export ports or domestic processing plants. The ports of concern are the western ports at Prince Rupert and Vancouver, and the eastern ports at Thunder Bay and Churchill. The producers deliver some grain to primary elevators and also store grain on the farm. The timing of these deliveries to the elevators is decided by the farmer. The CWB instructs the Canadian grain companies to purchase the required grain from the primary elevators in the producing blocks. Rail cars are then supplied by the CWB to the primary elevators to transport the grain to either the export port or domestic market. In addition to marketing the grain and providing

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* The CWB is responsible for marketing 80 percent of the grains, which are known as board grains. These board grains are wheat, barley and oats. Other grains are considered non-board grains, and are sold on the private market by grain companies. Off-board grains are the same as board grains but sold for domestic feed.

transportation equipment, the CWB also controls the rail rates for transport from the primary elevators to the terminal elevators. These rates are set at levels about 30 percent below railroad operating costs.(1)

Other government agencies are also involved in the Canadian grain industry. The Canadian Grain Commission establishes grading standards for grain, inspects and licenses elevators, authorizes the movement of producer-loaded cars and authorizes the mixing and blending of grades of grain. Through the establishment of the initial payment for CWB grains, the Canadian Government essentially sets a minimum price for the producers.

In conclusion, because of the widespread government control of the Canadian grain industry, the producers and grain companies are essentially removed from the grain marketing process. Therefore, the decision to export or sell domestically and the choice of export port is controlled, for the most part, by a single entity--the Canadian Government.

3. TONNAGE OF WHEAT AND BARLEY SHIPPED FROM THE GREAT LAKES PORTS HAS BEEN HIGHER AFTER 1970 THAN IN PREVIOUS YEARS

The tonnage of wheat and barley shipments from the lakehead (Thunder Bay) does not display any clear long-term trends. However, Table V-2 shows that shipments of wheat from the lakehead have, in general, been greater after the 1969-1971 period than in the previous decade. Between the 1969-1971 crop year and the 1978-1979 crop years, wheat shipments from the lakehead averaged about 8,500,000 metric tons. In contrast, between the 1959-1960 and 1969-1970 crop years, shipments averaged about 6,700,000 metric tons. Furthermore, the tonnage of wheat shipments from the lakehead after 1971 has been fairly constant. A similar pattern emerges for the shipments of barley from the lakehead. Between the crop years 1960-1969 the barley shipments averaged about 1,000,000 metric tons. After 1969, annual shipments of barley from the lakehead did not fall below 2,000,000 metric tons.

The increased tonnage of lakehead shipments of wheat has occurred despite the fact that the ratio of the shipments of wheat from the lakehead to total Canadian wheat exports has remained fairly constant. As indicated in Table V-3, between 1960 and 1979, the ratio of lakehead shipments of wheat to total exports in general remained between 60 and 70 percent.

TABLE V-2
Exports From the Lakehead
(Thousands of Metric Tons)

CROP YEARS	WHEAT	BARLEY	RYE	TOTAL
1959-60	5,117	1,268	103	7,118
1960-61	5,900	1,162	60	7,798
1961-62	4,890	768	103	6,223
1962-63	5,476	637	165	7,039
1963-64	9,455	1,043	112	11,365
1964-65	7,544	940	121	9,551
1965-66	10,121	1,059	157	12,288
1966-67	9,697	1,434	184	12,206
1967-68	4,716	825	85	6,294
1968-69	4,973	895	84	6,453
1969-70	5,955	2,050	79	8,871
1970-71	7,691	3,398	97	12,293
1971-72	8,583	4,193	131	14,064
1972-73	9,168	2,497	68	12,862
1973-74	8,222	2,157	102	11,069
1974-75	7,414	2,068	103	10,029
1975-76	9,311	2,223	218	12,396
1976-77	8,660	2,159	67	11,923
1977-78	9,073	2,735	158	12,599
1978-79[1]	8,393	2,843	57	12,064

1 Subject to revision.

Source: Statistics Canada: Grain Trade of Canada to 1977-78. 1978-79 from Canadian Grain Commission.

TABLE V-3
Ratio of Lakehead Shipments to Total Canadian Exports

	Lakehead Shipments of Wheat as a Percent of Total Canadian Wheat Exports	Lakehead Shipments of Barley and Rye as a Percentage of Total Canadian Barley and Rye Exports
	%	%
1960	78	91
1961	68	112
1962	55	83
1963	66	154
1964	64	99
1965	75	88
1966	68	118
1967	74	106
1968	56	89
1969	65	143
1970	69	105
1971	69	85
1972	66	82
1973	61	67
1974	75	78
1975	73	69
1976	80	53
1977	68	48
1978	60	75
1979	69	72

Source: Canadian Wheat Board, Annual Report.

The ratio of barley and rye lakehead shipments to total Canadian exports of these grains indicates that after 1971 the Lakes have become a slightly less important mode of transporting barley and rye, even though barley and rye production increased significantly in the years after 1971.

Thunder Bay receives prairie grain via the Canadian National and Canadian Pacific railroads. The primary central sources of this grain are Winnipeg, Superior Junction and Conme.

There are 13 major elevators at Thunder Bay. The major owners of these elevators are:

- Saskatchewan Wheat Pool - six elevators
- Cargill
- Parrish and Hembecker
- United Grain Growers
- Manitoba Wheat Pool - two elevators
- Richardson.

Grains at Thunder Bay are stored and cleaned in the elevators during the months when the Great Lakes/St. Lawrence Seaway is closed. In addition, some grains are moved from the prairies via rail (Canadian National and the Canadian Pacific) in winter months to East Coast ports for milling or direct export. This rail movement occurs only in winter months and does not compete with lake shipments during open navigation season.

When the navigation season opens, the cleaned grain is usually shipped from Thunder Bay by lakers to lower St. Lawrence Seaway ports. At these ports, the grain is either transferred to deep sea vessels for export, or consumed domestically. These laker shipments are often the backhaul leg of iron ore movements from the ore deposits in Labrador and Eastern Canada, and thus shipments of grain are dependent on iron ore movements.

The utilization of Great Lakes ports for Canadian grain shipments is expected to decline, compared to the utilization of West Coast ports. This expected decline is primarily due to the anticipated increase in the demand for wheat by Pacific rim countries. As demand increases in these countries, the Canadian Wheat Board will seek to minimize its transportation costs by routing prairie grain through West Coast elevators. In addition, the new grain facility being constructed at Prince Rupert will add to the capacity of West Coast ports and enable those ports to meet the increasing demand by the Pacific rim countries.

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VI. GREAT LAKES STEAM COAL

VI. GREAT LAKES STEAM COAL

1. INDUSTRY OVERVIEW AND OUTLOOK

This section describes the demand for coal in the Great Lakes area. The following sections address:

- Consuming industries
- Outlook for coal demand nationally
- Expected consumption in Great Lakes states.

(1) The Largest Coal-Consuming Sector Is Electricity Generation

The electricity-generation sector accounts for almost 80 percent of domestic coal consumption on a nationwide basis.(1) In the five westernmost Great Lakes border states (Wisconsin, Illinois, Indiana, Michigan and Ohio) the utility sector accounts for almost 97 percent of coal consumption. About 1.9 percent is consumed at coke plants, and about 1.4 percent is consumed for other industrial applications. Retail sales are negligible.

(2) Usage of Coal for Generation of Electricity Will Increase in the Future

As shown in Table VI-1, coal was the primary fuel for almost 39 percent of the nation's generating capacity at the end of 1979, more than any other single type of fuel. In addition, 58.7 percent of planned additions to capacity will use coal as the primary fuel.

In many parts of the country, coal is becoming a desirable fuel for power plants for a number of reasons:

- Domestic oil and gas reserves are diminishing and there is uncertainty about the availability of imported oil.

TABLE VI-1
U.S. Power Plant Capacity
December 1979

	Existing Capacity GWe2	Percent	Projected Additions GWe2	Percent	Projected Total Capacity	Percent	Percent Increase
Nuclear	54.7	9.1	63.4	27.2	118.1	14.1	115.9
Coal	234.6	38.9	136.7	58.7	371.3	44.5	58.3
Oil	151.3	25.1	11.6	5.0	162.9	19.5	7.7
Gas	79.6	13.2	0.2	0.1	79.8	9.6	0.3
Water	74.9	12.4	18.2	7.8	93.1	11.1	24.3
Other	7.4	1.2	2.6	1.1	10.0	1.2	34.2
Totals	602.5	100%	232.8	100%	835.2	100%	38.6

Notes: 1. Projections are through 1990.
2. GWe = Gigawatts electric = 1000 MW.

Source: U.S. Department of Energy, Inventory of Power Plants in the U.S. - December 1979.

- The safety and licensing procedures for nuclear plants are stringent.

- In spite of pollution control equipment costs, coal is now cost-competitive with oil.

The last point is illustrated in Table VI-2.

TABLE VI-2
Total Cost of Energy
(Dollars per Million Btus)

Fuel	1978	1979	1980
Coal	N/A	$ 2.15	$ 2.27
Oil	$ 2.14	$ 3.03	$ 4.07

Note: Total cost of coal includes $20 per short ton for pollution control equipment costs.

Source: World Coal Study.

In view of the above factors, many boilers are being converted from oil and gas to coal, and many new facilities will be designed to burn coal. Coal is expected to provide 57 percent of electric utility requirements by the year 2000. This is summarized in Table VI-3.

An outlook similar to the one above is shown in Table VI-4. The average annual growth rate of 4.3 percent is almost exactly the same as that given by the midpoint of the forecast range of Table VI-3.

TABLE VI-4
Coal Demand by Sector
(Millions of Short Tons)

Sector	1980	1985	1990	1995	2000	Growth Rate
Electric Utilities	554	678	822	1092	1287	4.3%
Coke	70	74	77	81	88	1.5%

Source: Coal Outlook, and DRI.

TABLE VI-3
Total Electricity Consumption, 1977-2000
(Units: mtce/yr. fuel input)*

Power Plant Type	1977	1985		1990		1995		2000	
		Low Coal	High Coal	Low Coal	High Coal	Low Coal	High Coal	Low Coal	High Coal
Coal	375	500	560	533	748	655	965	800	1170
Nuclear	97	200	220	280	320	300	400	300	600
All other	340	360	360	357	357	335	325	325	285
TOTAL	809	1060	1140	1170	1425	1290	1690	1425	2055
Coal penetration	46%	47%	49%	46%	52%	51%	56%	55%	57%

* 1 mtce (million tons coal equivalent) = 1.15 million short tons of bituminous coal at 12,000 Btu/lb. or 1.6 million short tons of subbituminous coal at 8,500 Btu/lb.

(3) <u>The Importance of Coal as a Utility Fuel Is More Pronounced in Great Lakes States</u>

In states bordering the Great Lakes, 54 percent of generating capacity is coal-fired. In Indiana and Ohio at least 85 percent of generating capacity is coal-fired. Several planned additions to generating capacity will also burn coal, as shown in Table VI-5.

TABLE VI-5
Electric Generating Capacity
(Thousands of Megawatts)

State	Existing Capacity		Projected Additional Capacity (1990)	
	Coal	Other	Coal	Other
New York	2.5	29.8	3.7	13.4
Illinois	16.9	13.0	5.3	11.4
Indiana	15.1	1.8	9.0	3.0
Michigan	10.4	10.8	2.6	5.5
Ohio	22.0	3.8	3.2	3.7
Minnesota	4.5	3.7	1.2	-
Wisconsin	5.9	4.0	3.5	1.2
Pennsylvania	18.7	14.7	3.0	8.5
TOTAL	96.0	81.6	31.5	46.7

Source: DOE, Inventory of Power Plants in the U.S., 1979.

There are 62 power plants that burn coal and that are located within 40 miles of the lake system. These plants are candidates for lake delivery of coal, and are summarized in Table VI-6.

TABLE VI-6
Coal-Fired Generating Capacity Near the Great Lakes

	Existing		Projected (1990)	
	No. of Plants	Capacity (MW)	No. of Plants	Capacity (MW)
New York	4	1873	3	2952
Illinois	5	4722	1	3300
Indiana	5	4124	1	776
Michigan	23	10508	6	1757
Ohio	13	4774	-	-
Minnesota	-	-	-	-
Wisconsin	10	3039	3	1634
Pennsylvania	2	750	1	625

Source: DOE, Inventory of Power Plants in the U.S., 1979.

Note: MW = megawatts.

2. COAL SUPPLY SOURCES

Almost all coal used by power plants in this country is domestically sourced. In the past 3 years, less than 1 percent has been imported, most of it to Florida from South Africa, Australia and Poland. The sections below describe the location of coal reserves, regional coal characteristics and regional production.

(1) Coal Reserves Are Concentrated in Six States

Coal is found in 31 states and currently mined in 26. Six states contain more than 75 percent of the nation's coal reserves: Montana (28 percent), Illinois (16 percent), Wyoming (13 percent), West Virginia (9 percent), Pennsylvania (7 percent), and Kentucky (6 percent). About one-half of all U.S. reserves are in the West, with the remainder split about equally between Appalachia and the Midwest. Table VI-7 shows the distribution of major reserves.

After accounting for coal losses during mining, there are roughly 270 billion short tons of economically recoverable reserves. This is enough to supply coal at the rate of 1979 U.S. coal production (770 billion tons) for 350 years. In other words, production could more than triple from present levels and there would still be more than a century's supply of reserves.

(2) Coal Varies Widely in Quality Characteristics

The most important coal characteristics are heat content (Btu/lb.), sulfur content, and ash content. Table VI-8 displays typical regional variations.

(3) While Most U.S. Coal Is Now Produced in Appalachian States, Most New Production Will Occur in Western States

Most of the coal now mined comes from the Appalachian fields. The major states which produce coal from these fields are Pennsylvania, Ohio, West Virginia, Kentucky, Virginia and Alabama. The Midwest coal fields are mostly in Illinois, Indiana and western Kentucky. Kentucky shares in major parts of both the Appalachian and Midwest coal fields. In the West, the major producers are Wyoming and Montana. There is significant production in several other states. Figure VI-1 shows production for all states in 1979. Note that Kentucky production is split between east and west, the total being 149.8 million tons.

TABLE VI-7
Demonstrated Coal Reserves
(Billions of Short Tons)

Colorado	16.3
Illinois	68.0
Indiana	10.7
Kentucky, East	13.5
Kentucky, West	12.5
Montana	120.6
Ohio	19.2
Pennsylvania	30.8
West Virginia	38.6
Wyoming	55.4
All Others	52.7
TOTAL	438.3

Source: World Coal Study.

TABLE VI-8
Illustrative Quality Characteristics of
Representative Coals

State	Coal Type	Btu/lb.*	Percent Sulfur*	Percent Ash*
Pennsylvania	Bituminous	12,067	2.03	15.0
West Virginia (North)	Bituminous	12,516	2.39	12.1
Ohio	Bituminous	11,047	3.42	15.8
Kentucky (East)	Bituminous	11,784	1.23	12.5
Illinois	Bituminous	10,775	2.92	11.4
Alabama	Bituminous	11,740	1.43	14.1
Texas	Lignite	6,601	0.66	12.0
Colorado	Bituminous	10,925	0.49	9.4
Wyoming	Subbituminous	9,037	0.50	8.3
Utah	Bituminous	11,569	0.63	11.9
North Dakota	Lignite	6,556	0.65	9.9
Montana	Subbituminous	8,957	0.64	7.6
Pennsylvania	Anthracite	8,607	0.69	27.3*

* On "as received" basis.

** Data distorted by reclaimed anthracite which lowers heat value.

Source: Federal Energy Regulatory Commission, <u>Annual Summary of Cost and Quality of Electric Utility Plant Fuels, 1977</u>, Table III, 1978.

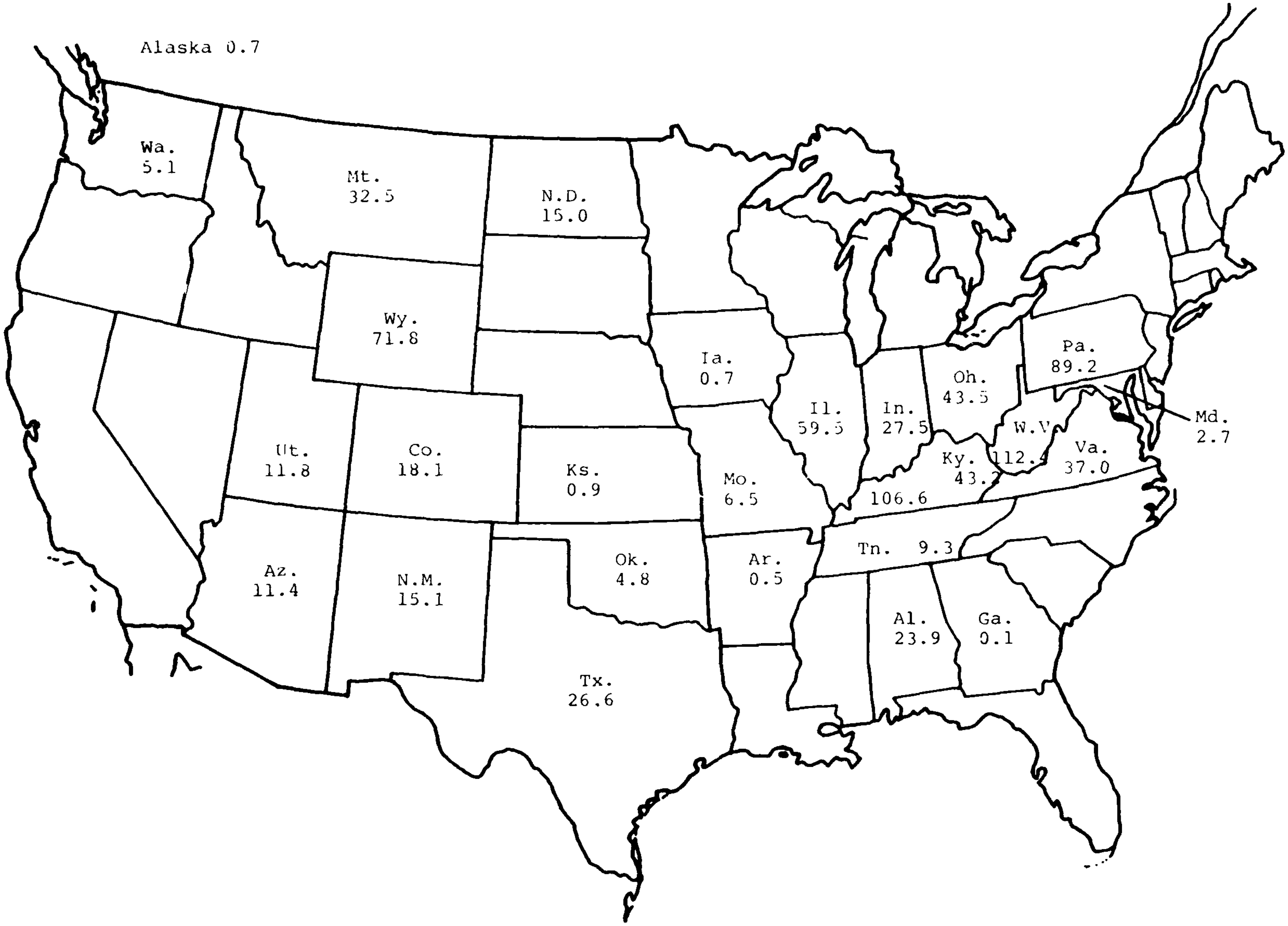


FIGURE VI-1
U.S. Coal Production by State - 1978
(Millions of Tons)

In the next several years, U.S. coal production is expected to increase tremendously. Although production in all areas will expand, the most rapid growth is expected in the West. There are several reasons for this. First, the coal mining industry in the East is old and well developed. The West, on the other hand, is relatively undeveloped and has more room for growth. Second, much of the Western coal can be mined by strip mining methods. This is much cheaper than the deep mining that is prevalent in the East. Third, the Western coal is very low in sulfur content and therefore presents less of a pollution problem than Eastern coal.

Changes in coal production in the 2 years from 1977 to 1979 are shown in Table VI-9. These data support the thesis of strong growth in the West and moderate growth in the East.

TABLE VI-9
Coal Production by State
(Millions of Tons)

State	Production 1977	1979	Percent Change
Montana	27.1	32.5	20
Colorado	12.0	18.1	51
Wyoming	44.0	71.8	63
Kentucky	147.5	149.8	2
West Virginia	95.4	112.4	18
Pennsylvania	85.7	89.2	4
Ohio	46.9	43.5	-7

Western coal has two major disadvantages relative to Eastern coals. First, it generally has much lower heat content per pound. Second, the remoteness from eastern or midwest markets makes transportation costs relatively high. Table VI-10 shows some relative prices, f.o.b. mine, that were paid in the spot market in mid-December, 1980.

TABLE VI-10
Spot Steam Coal Prices

Location	Btu/lb	Percent Sulfur	$/ton
Central Penn.	12,500	.76-1.5	28.00
Central Penn.	12,500	3.1 -4.0	21.50
Ohio	11,500	3.1 -4.0	17.00
E. Kentucky	11,500	1.6 -3.0	19.00
W. Kentucky	12,000	3.1 -4.0	19.00
Utah	12,000	0 -1.0	22.00
Wyoming	8,500	0 -1.0	7.50
Illinois	10,500	3.1 -4.0	16.00
Colorado	10,500	0 -0.75	14.50
Colorado	11,500	0 -0.75	20.00
Wyoming	9,000	0 -1.0	9.00
S.W. Virginia	12,500	0 -0.75	32.00

Source: Coal Outlook, December 22, 1980.

3. DISTRIBUTION SYSTEMS

This section describes the Great Lakes coal distribution system in terms of the following:

- Sourcing patterns
- Role of other modes in lake shipments
- Current traffic
- Location of coal consumers
- Future outlook.

Each of these subjects is described below.

(1) Power Plants Obtain Coal From a Variety of Sources

Table VI-11 identifies the states of origin for coal shipments to Great Lakes region power plants. Power plants in these states receive coal from several source states.

Individual utility plants generally do not have as many sources as the state in which they are located. Most plants receive coal from only one to four states, although often from many different mines. Some samples of individual plant sourcing are given in Table VI-12.

Different utilities in the region have different sourcing practices. Almost all use a mixture of short- and long-term supply contracts, as well as spot purchases.

TABLE VI-11
Origin/Destination States for Coal to Great Lakes States--1979
(Millions of Short Tons)

	Destination							
Origin	Illinois	Indiana	Michigan	Minnesota	New York	Ohio	Pennsylvania	Wisconsin
Arkansas	-	-	-	*	-	-	-	-
Colorado	1.8	0.8	-	-	-	-	-	-
Illinois	18.6	6.7	0.8	-	-	-	-	3.9
Indiana	1.0	20.7	*	-	-	-	-	0.3
Kentucky	1.6	4.2	9.1	*	0.4	12.4	*	2.0
Maryland	-	-	-	-	*	*	0.3	*
Missouri	*	-	-	-	-	-	-	-
Montana	4.1	0.8	3.7	11.4	-	-	-	2.7
N. Dakata	-	-	-	0.7	-	-	-	-
Ohio	-	0.4	5.0	*	-	27.6	2.0	0.3
Pennsylvania	-	-	0.8	*	5.6	1.6	3.8	1.3
Tennessee	-	-	-	*	-	-	-	-
Utah	0.1	1.3	-	-	-	*	-	-
Virginia	0.2	-	0.1	-	-	0.1	-	-
W. Virginia	0.1	*	4.6	-	0.2	8.0	4.8	*
Wyoming	9.1	1.9	-	-	-	3.6	-	2.5
Total Receipts	36.6	36.9	24.3	13.0	6.2	53.4	11.0	13.3

* Less than 100,000 tons.

Source: Department of Energy.

Major Sources for Each State:
Illinois: Illinois, Wyoming, Montana
Indiana: Indiana, Illinois, Kentucky
Michigan: Kentucky, Ohio, W. Virginia, Montana
Minnesota: Montana
New York: Pennsylvania
Ohio: Ohio, Kentucky, W. Virginia
Pennsylvania: W. Virginia, Pennsylvania, Ohio
Wisconsin: Illinois, Wyoming, Kentucky.

TABLE VI-12
Coal Sources for Selected Utilities--1979
(Thousands of Tons)

Utility and Plant	Mine and State	Volume
Niagara-Mohawk Power	Champion, PA	485
- Huntley Plant (N.Y.)	Sullivan, PA	455
	Blue Gem, KY	401
	Doverspike, PA	84
	All Sources	1459
Detroit Edison	Blacksville, WV	2304
- Monroe Plant (MI)	Georgetown, OH	1403
	Federal #2, WV	1300
	Shannon, PA	470
	Crest, KY	131
	Canada #2, KY	114
	Wells, WV	104
	All Sources	6912
- St. Clair Plant (MI)	Decker, MT	2500
	Powhatten, OH	131
	Georgetown, WV	115
	All Sources	2899
Upper Peninsula Generating Co.	Decker, MT	613
- Presque Isle Plant (MI)	Absaloka, MT	307
	Roseloud, MT	307
	Pevler, KY	301
	Wolverine, KY	192
	All Sources	2120

Note: Individual mines do not sum to "all sources"--minor sources are not listed.

Source: Department of Energy, F.P.C. Form No. 423.

Coals from different sources with different properties are often blended to produce a suitable fuel. Many older plants have boilers which can only operate with high-BTU coal. These plants therefore cannot burn Western coal. The cost to convert these plants to a system compatible with low-BTU coal is in most cases prohibitive.

(2) Great Lakes Coal Movements Involve Virtually All Modes of Transportation

In general, most Great Lakes coal movements are intermodal. This section describes the role of rail, truck, pipeline and inland waterway carriage of coal in overall Great Lakes coal traffic.

1. Rail

The major coal hauling railroads in the Great Lakes area are the Chessie System, Conrail, and the Norfolk & Western. Other less important, but significant, ones are the Bessemer & Lake Erie, the Illinois Central Gulf, the Louisville & Nashville, and the Burlington Northern which brings in most of the western coal to the area. Many movements are intercompany, with the coal traveling on more than one railroad's tracks before reaching its destination. An analysis of the importance of coal to the above-named railroads is shown in Table VI-13.

TABLE VI-13
Importance of Coal to Selected Railroads, 1978

	Tonnage (million tons)	Percent of Total	Revenue (million $)	Percent of Total
Bessemer & Lake Erie	5.2	48	32.4	33
Burlington Northern	63.0	44	463.7	24
Chessie System	70.2	42	500.9	32
Conrail	31.6	23	307.8	11
Illinois Central Gulf	15.0	24	69.5	10
Louisville & Nashville	53.7	62	224.6	28
Norfolk & Western	47.3	61	348.7	35

The greatest evolutionary change in coal transportation by rail in recent years has been the development of the unit train. The rolling stock of unit trains in coal usage is normally fully dedicated, and has a much higher utilization factor than other equipment. The savings in coal transportation cost over non-unit train operation can range from 25 to 40 percent. In 1972, unit trains handled 34.7 percent of railroad coal movements. By 1976 this had risen to 41.3 percent and was still increasing.(2)

It is an increasingly common practice for utilities to own some rolling stock themselves. Ownership of rail cars can protect the utility from supply disruption due to equipment shortages by the railroad. Equipment ownership can also provide an attractive return on investment as railroads charge

lower rates for movements utilizing shippers' equipment. Some utilities, such as Detroit Edison, even own some of their own locomotives.

Some power plants around the Great Lakes do not receive coal by rail because there is no line to or near the plant site, or because the existing roadbed is not in good enough shape to support full freight trains. Others which could physically receive coal by rail cannot do so economically (compared to water delivery). On the other hand, however, many waterfront plants receive only rail shipments. This is particularly true of facilities toward the southern ends of the Lakes.

2. Truck

Truck shipments of coal are generally of two major classifications: shipments from the mine directly to utilities, and shipment from mines without rail service to barge or rail loading points. Generally, truck shipment to utilities are only feasible within a short radius of the mine or where rail or water deliveries are not available.

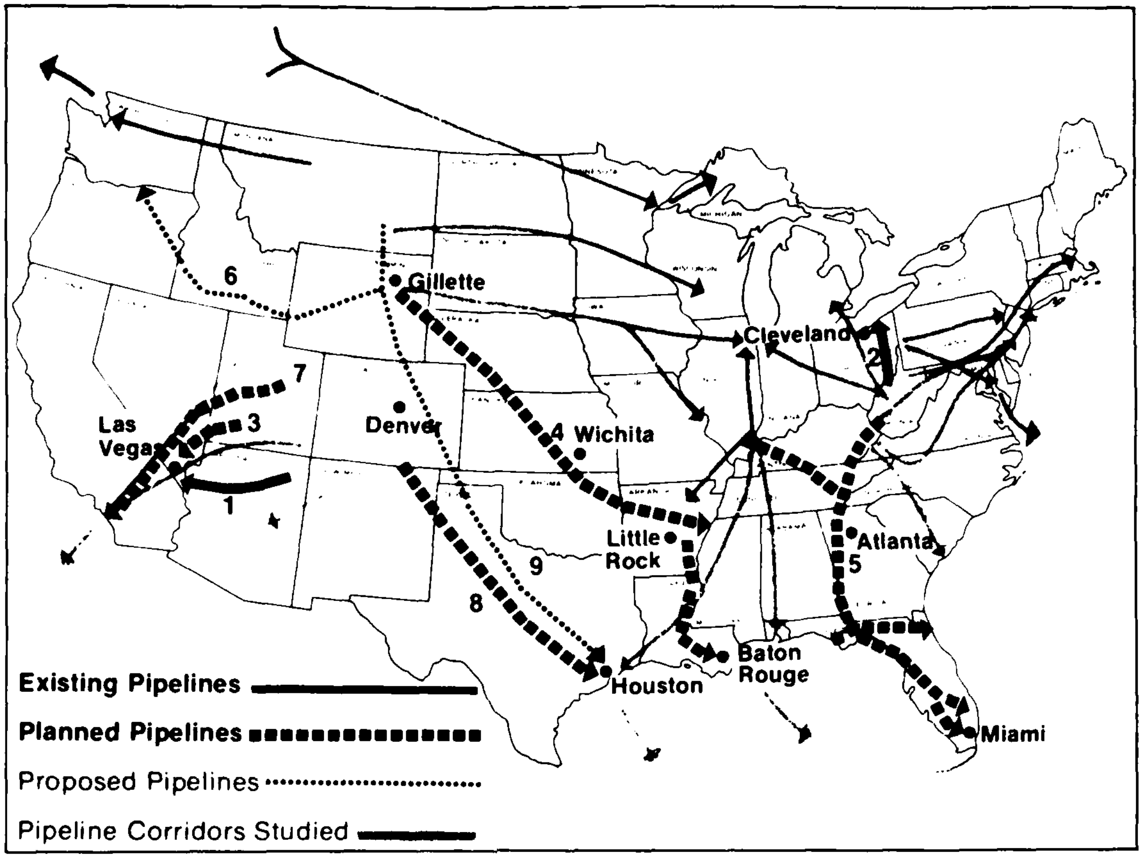
3. Pipeline

Several coal slurry pipelines are currently planned, one is operating, and an existing one is idle. Figure VI-2 shows the locations of all these projects. The only line that would have any potential impact on the Great Lakes area is the existing, but idle, pipeline from the West Virginia/Ohio border to Cleveland.

This existing pipeline has an annual throughput capacity of 1,300,000 tons and is 108 miles long. Compared with any of the currently planned pipelines, this existing one is small both in terms of length and capacity. It was built by Consolidation Coal Company and operated from 1957-63. It was closed down after railroads introduced unit trains and lowered freight rates from $3.47 per ton to $1.88 per ton.

4. Inland Waterways

The inland waterway system of the United States provides a major coal transportation network. This system, however, does not affect shipments on the Great Lakes, with the one exception of the Illinois River.



		Operational Date	Length (miles)	Capacity (m tons)
1.	Black Mesa	1971	273	4.8
2.	Ohio	Closed	108	1.3
3.	Allen-Warner Valley Energy System	1985-88	183	9.1
4.	Energy Transportation Systems, Inc.	1984	1,355	25.0
5.	Florida	1986	1,500	40-55
6.	Snake River	Indefinite	1,100	10.0
7.	Pacific Bulk Transportation System	Indefinite	645	10.0
8.	San Marco	1985	900	15.0
9.	Texas Eastern	Indefinite	1,260	25.0

Source: Slurry Transport Association, and Coal Traffic Annual.

FIGURE VI-2
Coal Slurry Pipelines

Commonwealth Edison buys coal for its Fisk, Crawford, and Will plants in the Chicago area from the Big Horn and Decker mines in Wyoming and Montana, respectively. This coal is brought from the West to Havana, Illinois, by Burlington Northern unit trains. Commonwealth Edison owns and operates a transfer facility at Havana which unloads the rail cars and loads the coal onto barges for carriage up the river to the plants. This volume of coal is about 4 million tons per year.

(3) On a Tonnage Basis, Lake Erie Ports Account for Most Great Lakes Coal Shipments

The vast majority of coal shipments on the Great Lakes are loaded on Lake Erie. There are only one Canadian and six U.S. ports that ship essentially all of the coal that moves on the Great Lakes. These ports are identified below:

- Lake Erie: Toledo, Sandusky, Ashtabula, Conneaut
- Lake Superior: Duluth/Superior, Thunder Bay
- Lake Michigan: Chicago.

Another port, Lorain, was a major coal loading port operated by the B&O Railroad until recently. This port is now owned by Republic Steel which uses the dock only for receiving iron ore and pellets.

The distribution of shipments by originating lake is given in Table VI-14.

TABLE VI-14
Bituminous Coal Shipments on the Great Lakes
(Thousands of Net Tons)

Year	From Lake Erie	From Lake Superior	From Lake Michigan	Total
1974	29,801	1,121	4,044	34,966
1975	33,175	2,061	3,943	39,179
1976	31,736	2,552	3,199	37,487
1977	32,032	3,917	3,035	38,984
1978	31,628	3,376	2,762	37,767

Source: Lake Carriers' Association. Anthracite shipments (not shown) totaled 40,000 tons.

Transfer facilities at shipping docks are owned by railroads, for the most part. Two exceptions are the terminals at Duluth/Superior (Detroit Edison) and Chicago (Rail/Water Transfer Corp.). Table VI-15 identifies the owner, throughput and capacity of major coal terminals.

TABLE VI-15
Great Lakes Coal Shipping Facilities

Location	Owner	Throughput (Million tons) 1980	1979	Approximate Annual Capacity (Million Tons)
Conneaut	Bessemer & Lake Erie	7.5	10.2	14
Toledo	Chessie	12.2	13.9	15-18
Sandusky	Norfolk & Western	6.2	5.7	18
Ashtabula	Conrail	5.4	6.4	7
Superior	Detroit Edison	4.0	4.0	12
Chicago	Rail/Water Transfer Corp.	3.0	3.0	N/A

Source: Dock operators.

The pattern of movements associated with each major lake source are described below.

1. Lake Erie Shipments

Bituminous coal shipments from Lake Erie ports are shown in Table VI-16. About half of the shipments are to U.S. ports (mostly steam coal) and half to Canadian ports. The shipments to Canada include about 2 million tons of metallurgical coal each from Sandusky and Conneaut to Canadian steel mills. About half of the U.S.-destined shipments terminate in the Lower Rivers area between Lakes Erie and Huron.

2. Lake Superior Shipments

The port of Duluth/Superior ships only steam coal, and only to two customers. These are Detroit Edison and the Upper Peninsula Generating Co. at Marquette, Michigan.

3. Lake Michigan Shipments

The only Lake Michigan port shipping coal in volume is Chicago. Shipments from Chicago have been declining in recent years, and are generally limited to other Lake Michigan destinations such as power plants in Milwaukee and Muskegon.

TABLE VI-16
Bituminous Coal Shipments From Lake Erie
(Thousands of Net Tons)
1978

To U.S. Ports: Loading Ports	To Lake Superior	To Sault Ste. Marie	To Lake Huron	To Lake Michigan	To Lower Rivers	To Lake Erie	Through Welland Canal	Total
Ashtar	284	-	142	500	135	521	-	1,492
Conneat	286	-	191	1,518	45	42	-	2,173
Lorain	-	-	83	-	165	568	-	816
Sandusky	534	-	15	75	411	43	-	1,077
Toledo	1,287	50	467	1,121	6,415	1,714		11,056
Total	2,391	50	898	3,214	7,171	2,889	-	16,614
Grand Total	2,391	50	898	3,214	7,171	2,889	-	16,614
To Canadian Ports: Loading Ports								
Ashtabula	106	24	-	-	1,554	1,449	695	3,828
Conneaut	93	-	-	-	1,640	2,223	1,657	5,612
Sandusky	-	-	-	-	-	-	2,241	2,241
Toledo	-	1,990	27	-	2	-	1,314	3,333
Total	198	2,014	27	-	3,196	3,672	5,908	15,014
Grand Total	2,590	2,064	925	3,214	10,367	6,560	5,908	13,628

Source: Coal Traffic Annual.

(4) <u>Most Great Lakes Coal Movements Are Controlled by Eight Utilities Representing 19 Power Plants</u>

Table VI-17 lists the principal U.S. electric utilities that receive water deliveries of coal, the location of the plants, and recent tonnages of coal received via the Lakes. The table does not identify power plants which receive less than 50,000 tons per year by water.

TABLE VI-17
U.S. Power Plants Receiving Great Lakes Coal Shipments

Company	Plant Name & Location	Annual Volume* via Lakes (1000 tons)
Niagara-Mohawk Power	Huntley, Tonawanda, NY	200
Detroit Edison	Monroe, MI	2,700
	Trenton, MI	500
	Pennsalt, Detroit, MI	125
	Connors Creek, Detroit, MI	350
	Marysville, MI	300
	Harbor Beach, MI	250
	St. Clair, MI	3,500
N. Michigan Electric Coop.	Advance, MI	110
Consumers' Power Co.	Cobb, Muskegon, MI	1,600
	Karn, Essexville, MI	300
	Weadock, Essexville, MI	
Holland Bd. of Pub. Works	Holland, MI	160
Grand Haven Bd. of L&P	Grand Haven, MI	90
Marquette Bd. of L&P	Marquette, MI	125
Upper Penin. Gen. Co.	Presque Isle, Marquette, MI	2,100
Wisconsin Pub. Serv. Comm.	Pulliam, Green Bay, WI	1,000
Wisconsin Electric Power	Valley, Milwaukee, WI	675
	Port Washington, WI	700

* Approximate volume in recent years.

All plants that are on the water do not necessarily receive coal by laker. In fact, many do not receive any by water. Most of the above-listed plants receive 100 percent of their shipments by water. There are exceptions, however. Niagara-Mohawk's Huntley plant at Tonawanda (Buffalo), New York, and Consumers' Power's Karn and Weadock plants at Essexville, Michigan, do not receive any water shipments of coal in some years. It is normally more economical for these plants to receive rail shipments.

Detroit Edison ships large quantities of coal from Toledo to Monroe, Michigan, a voyage of less than 3 hours. This is much more costly than direct shipment by rail--approximately $3 per ton. Some coal must be delivered by water, however, because rail facilities cannot handle the larger volume of coal (about 7 million tons per year) that the Monroe plant consumes.

The Great Lakes supplies U.S. coal to Canada utilities and steel mills. The principal utility customer is Ontario Hydro. Ontario Hydro received 9 million short tons of coal from West Virginia and Pennsylvania in 1978, 10.7 million in 1979, and over 9 million in 1980. It has contracts to receive about 10 million tons in 1981 from U.S. mines, and 2.85 million tons from Western Canada via Thunder Bay. Table VI-18 shows the plants which receive deliveries from the Great Lakes, their location and size.

TABLE VI-18
Ontario Hydro Plants

Plant	Location	Generating Units	Capacity (MW)
Lambton	Sarnia	4	2000
J.C. Keith*	Windsor	4	264
Nanticoke	Nanticoke	8	4000
Lakeview	Toronto	8	2400
R.L. Hearn	Toronto	8	1200

* Inactive, on standby status.

Source: Ontario Hydro.

In 1973 the utility decided to diversify its coal supply by establishilng long-term sources in Western Canada. Building a terminal at Thunder Bay, upgrading rail lines, developing mining facilities, and obtaining permits took several years. The coal movement from Alberta and British Columbia began in mid-1978. The nominal annual volume to come from this source is about 2.7 million tons. Because of the long distance and the low-Btu content of Western Canadian coal, the delivered cost per Btu in 1979 was 38 percent higher than U.S. coal.

Ontario Hydro's coal is carried by two companies, Canada Steamship Lines and Upper Lakes Shipping. These two carriers move the coal in roughly equal proportions.

Canadian steel mills also receive U.S. coal via the Great Lakes. In 1978 the Algoma steel mill at Sault Ste. Marie received almost 2 million tons of metallurgical coal from Toledo. Sandusky and Toledo shipped 3,555,000 tons through the Welland Canal to Hamilton where the Steel Company of Canada (Stelco) and Dominion Foundry and Steel (Dofasco) are located. Beginning in 1980 there were also shipments from these ports to Nanticoke on Lake Erie where Stelco's new plant is located.

(5) The Major Change Expected for the Great Lakes Is Increased Shipments From Duluth/Superior

The trend in the Great Lakes area is toward increased use of western coal. This trend is heightened by the low heat content of the western coal. This coal is mostly subbituminous, with a lower heat content than bituminous coal. Subbituminous coal delivered to electric utilities in the last 5 years had an average of 9,200 Btu/lb. compared to bituminous coal with an average heat content of 1,350 Btu/lb. The effect is that almost 25 percent more subbituminous coal is needed to produce the same amount of heat as a given volume of bituminous coal.

Only 800,000 tons of coal were shipped from Duluth/Superior in 1974. This rose steadily to over 3 million tons in both 1977 and 1978, and to a current level of about 4 million tons. Most of this coal is shipped to the Detroit Edison plant on the St. Clair River.

The recently completed National Energy Transportation Study, a joint study of the Departments of Energy and Transportation, predicts that as much as 40 million tons per year of coal might move from Duluth/Superior to Detroit and Lake Erie ports by 1990. This coal would originate mostly in Montana and would be moved to Duluth/Superior by unit train. At least two new Detroit Edison power plants are expected to burn western coal. These plants are at Belle River and at Harbor Beach.

Another potential development is the possibility of coal exports to overseas destinations. Until recently these exports have been negligible. In 1980 there was an overseas export movement of 150,000 tons from Conneaut.

Increased worldwide demand for U.S. coal and extreme congestion at traditional U.S. export ports (primarily Hampton Roads) has helped to initiate a number of coal export projects. Some Ohio ports are preparing to load

coal for transshipment beyond Montreal. The Port of Erie, Pennsylvania, is bringing on stream a new facility for coal transshipment capable of handling 200,000 tons per year. There is a facility operating at Quebec City whose annual throughput capacity is estimated at 500,000 long tons. A large facility is being planned 120 miles downriver from Quebec City. Coal handling capacity there is planned at 10-15 million tons per year.

One major problem with exports of coal out of the Great Lakes is the ship size restrictions of the GL/SLS locks. The 30,000 DWT vessels that can reach the coal loading ports are not of an economical size for most ocean commerce in coal. This necessitates the transfer of coal to large ocean vessels at some point in the St. Lawrence outside of Montreal. This procedure is much more costly than direct loading into bulkers at the export port. The economics of smaller ships and rehandling will determine whether the Great Lakes can compete with deepwater U.S. ports over the long term for the coal export market.

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